

# EXHIBIT C

**Application for Federal Assistance SF-424**

* 1. Type of Submission:	* 2. Type of Application:	* If Revision, select appropriate letter(s):
<input type="checkbox"/> Preapplication <input checked="" type="checkbox"/> Application <input type="checkbox"/> Changed/Corrected Application	<input checked="" type="checkbox"/> New <input type="checkbox"/> Continuation <input type="checkbox"/> Revision	<input type="text"/>
* 3. Date Received:		4. Applicant Identifier:
<input type="text" value="01/13/2022"/>		<input type="text"/>
5a. Federal Entity Identifier:		5b. Federal Award Identifier:
<input type="text"/>		<input type="text"/>
<b>State Use Only:</b>		
6. Date Received by State:	<input type="text"/>	
7. State Application Identifier: <input type="text" value="Choose State..."/>		
<b>8. APPLICANT INFORMATION:</b>		
* a. Legal Name: <input type="text" value="Regents of the University of California"/>		
* b. Employer/Taxpayer Identification Number (EIN/TIN):		* c. Organizational DUNS:
<input type="text" value="94-6002123"/>		<input type="text" value="1247267250000"/>
<b>d. Address:</b>		
* Street1:	<input type="text" value="1608 Fourth Street, Suite 220"/>	
Street2:	<input type="text" value="Mail Code 5940"/>	
* City:	<input type="text" value="Berkeley"/>	
County/Parish:	<input type="text" value="Choose State..."/>	
* State:	<input type="text" value="CA: California"/>	
Province:	<input type="text"/>	
* Country:	<input type="text" value="USA: UNITED STATES"/>	
* Zip / Postal Code:	<input type="text" value="94710-1749"/>	
<b>e. Organizational Unit:</b>		
Department Name:	<input type="text" value="School of Law"/>	
<input type="text"/>		Division Name:
<b>f. Name and contact information of person to be contacted on matters involving this application:</b>		
Prefix:	<input type="text" value="Miss"/>	* First Name: <input type="text" value="Margaret"/>
Middle Name:	<input type="text"/>	
* Last Name:	<input type="text" value="Nguyen"/>	
Suffix:	<input type="text"/>	
Title:	<input type="text" value="Contract and Grant Officer"/>	
Organizational Affiliation:		
<input type="text" value="Regents of the University of California"/>		
* Telephone Number:	<input type="text" value=" (510) 664-7489"/>	Fax Number: <input type="text"/>
* Email:	<input type="text" value="nguyen_m@berkeley.edu"/>	

**Application for Federal Assistance SF-424****\* 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

\* Other (specify):

**\* 10. Name of Federal Agency:**

Environmental Protection Agency

**11. Catalog of Federal Domestic Assistance Number:**

66.509

CFDA Title:

Science To Achieve Results (STAR) Research Program

**\* 12. Funding Opportunity Number:**

EPA-G2022-STAR-C1

\* Title:

LIFE-CYCLE ANALYSIS TO SUPPORT COST-EFFECTIVE ENHANCED AQUIFER RECHARGE

**13. Competition Identification Number:**


Title:

**14. Areas Affected by Project (Cities, Counties, States, etc.):**
   
**\* 15. Descriptive Title of Applicant's Project:**

Developing tools and resources to enable economic, institutional, and technical clarity in support of Enhanced Aquifer Recharge implementation

Attach supporting documents as specified in agency instructions.

**Application for Federal Assistance SF-424****16. Congressional Districts Of:**

\* a. Applicant CA-013

\* b. Program/Project CA-013

Attach an additional list of Program/Project Congressional Districts if needed.

	Add Attachment	Delete Attachment	View Attachment
--	----------------	-------------------	-----------------

**17. Proposed Project:**

\* a. Start Date: 07/01/2022

\* b. End Date: 06/30/2025

**18. Estimated Funding (\$):**

* a. Federal	2,000,000.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	2,000,000.00

**\* 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

a. This application was made available to the State under the Executive Order 12372 Process for review on 01/12/2022.

b. Program is subject to E.O. 12372 but has not been selected by the State for review.

c. Program is not covered by E.O. 12372.

**\* 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)** Yes  No

If "Yes", provide explanation and attach

	Add Attachment	Delete Attachment	View Attachment
--	----------------	-------------------	-----------------

21. \*By signing this application, I certify (1) to the statements contained in the list of certifications\*\* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances\*\* and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)

 \*\* I AGREE

\*\* The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

**Authorized Representative:**

Prefix: Ms. \* First Name: Margaret

Middle Name:

\* Last Name: Nguyen

Suffix:

\* Title: Contracts and Grants Officer

\* Telephone Number: 510-664-7489 Fax Number:

\* Email: spo\_grants\_gov@lists.berkeley.edu

\* Signature of Authorized Representative: Margaret Nguyen \* Date Signed: 01/13/2022



## EPA KEY CONTACTS FORM

OMB Number: 2030-0020  
Expiration Date: 06/30/2024

**Authorized Representative:** Original awards and amendments will be sent to this individual for review and acceptance, unless otherwise indicated.

<b>Name:</b>	Prefix: <input type="text" value="Ms."/>	First Name: <input type="text" value="Margaret"/>	Middle Name: <input type="text"/>
		Last Name: <input type="text" value="Nguyen"/>	Suffix: <input type="text"/>
<b>Title:</b>	<input type="text" value="Contracts and Grants Officer"/>		
<b>Complete Address:</b>			
Street1:	<input type="text" value="1608 Fourth Street, Suite 220"/>		
Street2:	<input type="text" value="Mail Code 5940"/>		
City:	<input type="text" value="Berkeley"/>	State:	<input type="text" value="CA: California"/>
Zip / Postal Code:	<input type="text" value="94710-1749"/>	Country:	<input type="text" value="USA: UNITED STATES"/>
<b>Phone Number:</b>	<input type="text" value="510-664-7489"/>	<b>Fax Number:</b>	<input type="text"/>
<b>E-mail Address:</b>	<input type="text" value="spo_grants_gov@lists.berkeley.edu"/>		

**Payee:** Individual authorized to accept payments.

<b>Name:</b>	Prefix: <input type="text" value="Ms."/>	First Name: <input type="text" value="Elizabeth"/>	Middle Name: <input type="text"/>
		Last Name: <input type="text" value="Chavez"/>	Suffix: <input type="text"/>
<b>Title:</b>	<input type="text" value="Director"/>		
<b>Complete Address:</b>			
Street1:	<input type="text" value="2195 Hearst Avenue, Room 130"/>		
Street2:	<input type="text" value="Mail Code 1103"/>		
City:	<input type="text" value="Berkeley"/>	State:	<input type="text" value="CA: California"/>
Zip / Postal Code:	<input type="text" value="94720-1103"/>	Country:	<input type="text" value="USA: UNITED STATES"/>
<b>Phone Number:</b>	<input type="text" value="510-643-4246"/>	<b>Fax Number:</b>	<input type="text"/>
<b>E-mail Address:</b>	<input type="text" value="CGAawards@berkeley.edu"/>		

**Administrative Contact:** Individual from Sponsored Programs Office to contact concerning administrative matters (i.e., indirect cost rate computation, rebudgeting requests etc).

<b>Name:</b>	Prefix: <input type="text" value="Ms."/>	First Name: <input type="text" value="Margaret"/>	Middle Name: <input type="text"/>
		Last Name: <input type="text" value="Nguyen"/>	Suffix: <input type="text"/>
<b>Title:</b>	<input type="text" value="Contracts and Grants Analyst"/>		
<b>Complete Address:</b>			
Street1:	<input type="text" value="1608 Fourth Street, Suite 220"/>		
Street2:	<input type="text" value="Mail Code 5940"/>		
City:	<input type="text" value="Berkeley"/>	State:	<input type="text" value="CA: California"/>
Zip / Postal Code:	<input type="text" value="94710-1749"/>	Country:	<input type="text" value="USA: UNITED STATES"/>
<b>Phone Number:</b>	<input type="text" value="510-664-7489"/>	<b>Fax Number:</b>	<input type="text"/>
<b>E-mail Address:</b>	<input type="text" value="nguyen_m@berkeley.edu"/>		

## EPA KEY CONTACTS FORM

**Project Manager:** *Individual responsible for the technical completion of the proposed work.*

**Name:** Prefix:  First Name:  Middle Name:   
**Last Name:**  Suffix:

**Title:**

**Complete Address:**

**Street1:**

**Street2:**

**City:**  **State:**

**Zip / Postal Code:**  **Country:**

**Phone Number:**  **Fax Number:**

**E-mail Address:**

**Preaward Compliance Review Report for  
All Applicants and Recipients Requesting EPA Financial Assistance**

Note: Read Instructions before completing form.

**I. A. Applicant/Recipient (Name, Address, City, State, Zip Code)**

Name:

Address:

City:

State:  Zip Code:

**B. DUNS No.**

**II. Is the applicant currently receiving EPA Assistance?**  Yes  No

**III. List all civil rights lawsuits and administrative complaints pending against the applicant/recipient that allege discrimination based on race, color, national origin, sex, age, or disability. (Do not include employment complaints not covered by 40 C.F.R. Parts 5 and 7.)**

UC Berkeley's Office for the Prevention of Harassment and Discrimination has 27 pending investigations of administrative complaints as of 8/3/19. No lawsuits have been decided against UC Berkeley.

**IV. List all civil rights lawsuits and administrative complaints decided against the applicant/recipient within the last year that allege discrimination based on race, color, national origin, sex, age, or disability and enclose a copy of all decisions. Please describe all corrective actions taken. (Do not include employment complaints not covered by 40 C.F.R. Parts 5 and 7.)**

UC Berkeley's Office for the Prevention of Harassment and Discrimination conducted 31 Investigations closed between 7/1/18 - 6/30/19. No lawsuits have been decided against UC Berkeley.

**V. List all civil rights compliance reviews of the applicant/recipient conducted by any agency within the last two years and enclose a copy of the review and any decisions, orders, or agreements based on the review. Please describe any corrective action taken. (40 C.F.R. § 7.80(c)(3))**

California State Audit: June 2018 - findings and recommendations in linked report: <https://www.auditor.ca.gov/pdfs/reports/2013-124.pdf>

U.S. Dept. of Education Office for Civil Rights, investigation of complaint nos. 90-14-2322, 09-15-2392 and 09-16-2399. Resolution agreement and resolution letter attached. NASA Title IX Compliance Review of UC Berkeley's Astronomy Department 2016-2018. Report issued and monitoring in progress.

**VI. Is the applicant requesting EPA assistance for new construction? If no, proceed to VII; if yes, answer (a) and/or (b) below.**

Yes  No

**a. If the grant is for new construction, will all new facilities or alterations to existing facilities be designed and constructed to be readily accessible to and usable by persons with disabilities? If yes, proceed to VII; if no, proceed to VI(b).**

Yes  No

**b. If the grant is for new construction and the new facilities or alterations to existing facilities will not be readily accessible to and usable by persons with disabilities, explain how a regulatory exception (40 C.F.R. 7.70) applies.**

**VII. Does the applicant/recipient provide initial and continuing notice that it does not discriminate on the basis of race, color, national origin, sex, age, or disability in its program or activities? (40 C.F.R. 5.140 and 7.95)**

Yes  No

**a. Do the methods of notice accommodate those with impaired vision or hearing?**

Yes  No

**b. Is the notice posted in a prominent place in the applicant's offices or facilities or, for education programs and activities, in appropriate periodicals and other written communications?**

Yes  No

**c. Does the notice identify a designated civil rights coordinator?**

Yes  No

VIII. Does the applicant/recipient maintain demographic data on the race, color, national origin, sex, age, or handicap of the population it serves? (40 C.F.R. 7.85(a))  Yes  No

IX. Does the applicant/recipient have a policy/procedure for providing access to services for persons with limited English proficiency? (40 C.F.R. Part 7, E.O. 13166)  Yes  No

X. If the applicant is an education program or activity, or has 15 or more employees, has it designated an employee to coordinate its compliance with 40 C.F.R. Parts 5 and 7? Provide the name, title, position, mailing address, e-mail address, fax number, and telephone number of the designated coordinator.

At UC Berkeley, the Office for the Prevention of Harassment and Discrimination handles all administrative complaints of discrimination (including harassment) on the basis of sex, gender, gender identity and expression, sexual orientation and pregnancy for all faculty, staff, students, applicants and visitors. The campus Title IX Officer is housed in this office:

Elizabeth Rome  
Title IX Officer and Interim Associate Director  
Office for the Prevention of Harassment and Discrimination (OPHD)  
2111 Bancroft Way, Suite 300, MC 1130  
University of California  
Berkeley CA 94620  
Tel: 510 642-7985  
Email: ask\_ophd.berkeley.edu

XI. If the applicant is an education program or activity, or has 15 or more employees, has it adopted grievance procedures that assure the prompt and fair resolution of complaints that allege a violation of 40 C.F.R. Parts 5 and 7? Provide a legal citation or Internet Address for, or a copy of, the procedures.

A number of different grievance procedures apply for staff, faculty and students at UC Berkeley: Staff: <http://hr.berkeley.edu/policies/policies-procedures/university/discrimination>  
Students: <http://sa.berkeley.edu/grievance>  
Faculty: <http://ofew.berkeley.edu/equity/grievances>

#### For the Applicant/Recipient

I certify that the statements I have made on this form and all attachments thereto are true, accurate and complete. I acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law. I assure that I will fully comply with all applicable civil rights statutes and EPA regulations.

A. Signature of Authorized Official

Margaret Nguyen

B. Title of Authorized Official

Contracts and Grants Officer

C. Date

01/13/2022

#### For the U.S. Environmental Protection Agency

I have reviewed the information provided by the applicant/recipient and hereby certify that the applicant/recipient has submitted all preaward compliance information required by 40 C.F.R. Parts 5 and 7; that based on the information submitted, this application satisfies the preaward provisions of 40 C.F.R. Parts 5 and 7; and that the applicant has given assurance that it will fully comply with all applicable civil rights statutes and EPA regulations.

A. \*Signature of Authorized EPA Official

\_\_\_\_\_

B. Title of Authorized Official

\_\_\_\_\_

C. Date

\_\_\_\_\_

**\* See Instructions**

Instructions for EPA FORM 4700-4 (Rev. 06/2014)

General. Recipients of Federal financial assistance from the U.S. Environmental Protection Agency must comply with the following statutes and regulations.

Title VI of the Civil Rights Act of 1964 provides that no person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. The Act goes on to explain that the statute shall not be construed to authorize action with respect to any employment practice of any employer, employment agency, or labor organization (except where the primary objective of the Federal financial assistance is to provide employment). Section 13 of the 1972 Amendments to the Federal Water Pollution Control Act provides that no person in the United States shall on the ground of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under the Federal Water Pollution Control Act, as amended. Employment discrimination on the basis of sex is prohibited in all such programs or activities. Section 504 of the Rehabilitation Act of 1973 provides that no otherwise qualified individual with a disability in the United States shall solely by reason of disability be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. Employment discrimination on the basis of disability is prohibited in all such programs or activities. The Age Discrimination Act of 1975 provides that no person on the basis of age shall be excluded from participation under any program or activity receiving Federal financial assistance. Employment discrimination is not covered. Age discrimination in employment is prohibited by the Age Discrimination in Employment Act administered by the Equal Employment Opportunity Commission. Title IX of the Education Amendments of 1972 provides that no person in the United States on the basis of sex shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance. Employment discrimination on the basis of sex is prohibited in all such education programs or activities. Note: an education program or activity is not limited to only those conducted by a formal institution. 40 C.F.R. Part 5 implements Title IX of the Education Amendments of 1972. 40 C.F.R. Part 7 implements Title VI of the Civil Rights Act of 1964, Section 13 of the 1972 Amendments to the Federal Water Pollution Control Act, and Section 504 of The Rehabilitation Act of 1973. The Executive Order 13166 (E.O. 13166) entitled; "Improving Access to Services for Persons with Limited English Proficiency" requires Federal agencies work to ensure that recipients of Federal financial assistance provide meaningful access to their LEP applicants and beneficiaries.

Items "Applicant" means any entity that files an application or unsolicited proposal or otherwise requests EPA assistance. 40 C.F.R. §§ 5.105, 7.25. "Recipient" means any entity, other than applicant, which will actually receive EPA assistance. 40 C.F.R. §§ 5.105, 7.25. "Civil rights lawsuits and administrative complaints" means any lawsuit or administrative complaint alleging discrimination on the basis of race, color, national origin, sex, age, or disability pending or decided against the applicant and/or entity which actually benefits from the grant, but excluding employment complaints not covered by 40 C.F.R. Parts 5 and 7. For example, if a city is the named applicant but the grant will actually benefit the Department of Sewage, civil rights lawsuits involving both the city and the Department of Sewage should be listed. "Civil rights compliance review" means any review assessing the applicant's and/or recipient's compliance with laws prohibiting discrimination on the basis of race, color, national origin, sex, age, or disability. Submit this form with the original and required copies of applications, requests for extensions, requests for increase of funds, etc. Updates of information are all that are required after the initial application submission. If any item is not relevant to the project for which assistance is requested, write "NA" for "Not Applicable." In the event applicant is uncertain about how to answer any questions, EPA program officials should be contacted for clarification. \* Note: Signature appears in the Approval Section of the EPA Comprehensive Administrative Review For Grants/Cooperative Agreements & Continuation/Supplemental Awards form.

## A knowledge-to-implementation framework for Enhanced Aquifer Recharge

### Table of Contents

<b>Abstract .....</b>	<b>2</b>
<b>Research Plan.....</b>	<b>3</b>
1. <i>Introduction and objectives.....</i>	<i>3</i>
2. <i>Approach and Activities .....</i>	<i>4</i>
2.1. <i>Overview of methods and approach.....</i>	<i>4</i>
2.2. <i>Pillar 1: Geochemical and physical considerations.....</i>	<i>6</i>
2.3. <i>Pillar 2: Legal &amp; institutional considerations .....</i>	<i>7</i>
2.4. <i>Pillar 3: Cost-benefit analysis &amp; life-cycle assessment.....</i>	<i>9</i>
3. <i>Expected results, benefits, outputs, and outcomes .....</i>	<i>12</i>
3.1. <i>Pillar 1 Outputs: Geochemical and physical considerations .....</i>	<i>12</i>
3.2. <i>Pillar 2 Outputs: Legal &amp; institutional considerations .....</i>	<i>13</i>
3.3. <i>Pillar 3 Outputs: Cost-benefit analysis &amp; life-cycle assessment .....</i>	<i>13</i>
3.4. <i>Integration &amp; communication .....</i>	<i>13</i>
4. <i>Innovation .....</i>	<i>14</i>
5. <i>Sustainability.....</i>	<i>15</i>
6. <i>Project management .....</i>	<i>15</i>
7. <i>Conclusion .....</i>	<i>17</i>
<b>Quality Assurance Statement .....</b>	<b>18</b>
<b>Human Subjects Research Statement .....</b>	<b>20</b>
<b>Scientific Data Management Plan .....</b>	<b>23</b>
<b>Community Engagement Plan .....</b>	<b>25</b>
<b>References.....</b>	<b>29</b>

## Abstract

Funding Opportunity: Life-cycle analysis to support cost effective enhanced aquifer recharge (EPA-G2022-STAR-C1)

Project Title: A knowledge-to-implementation framework for Enhanced Aquifer Recharge

Investigators: PI: Michael Kiparsky (UC Berkeley); co-PIs: Ellen Bruno (UC Berkeley); Helen Dahlke, Thomas Harter (UC Davis); Andrew T. Fisher (UC Santa Cruz); Dave Owen (UC Hastings School of Law). Additional information on team leadership is available at:

[clec.berkeley.edu](http://clec.berkeley.edu); [are.berkeley.edu](http://are.berkeley.edu); <https://websites.pmc.ucsc.edu/~afisher/>;  
<https://watershed.ucdavis.edu>; <https://www.uchastings.edu/people/dave-owen/>

### Institutions:

University of California, Berkeley, Berkeley, California (applying institution)

University of California, Davis, Davis, California

University of California, Santa Cruz, Santa Cruz, California

UC Hastings Law, San Francisco, California

Project period and location: July 1, 2022 – June 30, 2025, at the four campuses above plus field locations nationwide.

Project cost: \$2,000,000 (including all direct and indirect costs)

### Project summary:

*Objective:* We aim to contribute to the nation's water-related human, environmental, and economic well-being by removing barriers, developing tools, and providing knowledge in service of implementation of Enhanced Aquifer Recharge (EAR). We conceptualize a life cycle view of EAR to encompass **three pillars of decision making** for EAR: **geochemical and physical considerations; legal & institutional considerations; and cost-benefit analysis & life-cycle assessment**. Our **overarching hypothesis** is that through strategically combining applied research, decision-support innovations, and public engagement, we can lower barriers to widespread adoption of EAR and unlock its potential to provide multiple water security benefits.

*Approach:* To address these issues, we propose a knowledge-to-action program that combines information synthesis and targeted research, novel tool development, and strategic dissemination, informed throughout by focused engagement. Because of the strength of our team's background and ongoing activity on EAR, our general approach to advancing each topic will be to **build directly on extensive ongoing efforts**, leveraging EPA support to a) generalize and contextualize cutting edge research contributions, b) build and articulate conceptual bridges among currently siloed topics to produce a comprehensive picture of the life cycle of EAR implementation, and c) extend scholarly insights to create actionable recommendations for practitioners. The program will develop and formalize best practices for EAR, using methods and approaches consistent with EPA's stated vision for this topic

*Expected results:* Our capstone product will be an **EAR Lifecycle Map, an integrative report** that summarizes the results of and interconnections among all research components. The report will serve as a roadmap for decision-makers contemplating EAR projects, and a repository from which key resources and tools can be found and evaluated. The EAR Lifecycle Map will embody co-production and relevance through structured engagement, and will be supported by cutting-edge research products, syntheses, and decision tools.

Supplemental keywords: Managed Aquifer Recharge (MAR); Infiltration; Groundwater recharge; Interdisciplinary; Innovation; Incentives; Public policy; Pollution prevention; Law; Economics of groundwater recharge; Water resources; Environmental policy

## Research Plan

### 1. Introduction and objectives

Groundwater depletion is causing severe impacts to human and environmental systems to accumulate across the United States, including unreliable water supply, land subsidence and damage to crucial infrastructure, impaired water quality, reduced surface water flows, harm to groundwater dependent ecosystems, and damage to the aquifer systems themselves [2]. Climate change is exacerbating these trends, as more extreme flood and drought regimes and intensifying demand push groundwater resources further away from sustainability.

In the face of these challenges, water and environmental managers are increasingly turning to Enhanced Aquifer Recharge (EAR). EAR involves the use of engineered or natural infrastructure to intentionally recharge aquifers. Techniques include managed aquifer recharge (MAR), artificial recharge, aquifer storage and recovery (ASR), and related practices [3-6]. Coupled with demand management and other conservation approaches, EAR holds significant promise as a crucial tool for alleviating stresses on groundwater systems [3, 5, 7]. A range of purposes and outcomes motivate EAR, including mitigating the impacts of drought exacerbated by climate change, combating saltwater intrusion in coastal aquifers, diluting contaminants in drinking water supplies, reducing land subsidence, and increasing water supply reliability [8]. However, fulfilling the promise of EAR to avoid the major and often irreversible social, economic, and environmental impacts of widespread groundwater mismanagement will require acceleration in the pace and effectiveness of EAR implementation.

Knowledge about EAR is growing, particularly on technical topics, but important issues remain unresolved. Analyses have focused on physical methods for recharge (see, e.g. [3, 5, 7]) and advancements in hydrogeological tools including, crucially, tools for selection of physically appropriate sites (see, e.g., [9, 10]). Understanding of water quality has increased, including knowledge about constituents of concern, contaminant transport and tracing, and the evolution of regulations related to EAR (see, e.g., [2, 11]).

These advancements are foundational for scaling EAR implementation, but two crucial elements remain essential for actualizing its promise. First, extensive and detailed EAR case study development by our research team has revealed that crucial economic, institutional, geochemical and physical elements of EAR implementation remain understudied and poorly understood. These gaps present hurdles to implementation. Even EAR is technically viable, it may not be clear to those without access to specialized knowledge and resources [8].

Second, a crucial and unaddressed bottleneck for scaling EAR is the need for digestion and dissemination of knowledge and experience so it can be readily accessed, understood, and acted upon by relevant decision makers and interested stakeholders. Effective tools, guidance, tailored information, and decision frameworks are sorely needed to enable broader adoption and diffusion of EAR. Furthermore, while bespoke analyses are available from cutting edge academic and consulting sources, a lack of broadly applicable and accessible tools and guidance hinders efforts to develop new EAR projects.

To address these issues, we propose to develop a knowledge-to-implementation program that combines a) information synthesis and targeted research, b) novel tool development, and c) strategic dissemination, informed throughout by focused engagement. This program will build on principles developed in efforts to bring scientific knowledge to bear on pressing real world problems [12], including addressing a key challenge in science communication: bridging abstract or conceptual scientific understanding with relevant real-world decision-making. Our efforts will prioritize co-production of knowledge with practitioners and decision-makers, both to focus our

efforts on the elements that matter most to them, and to ensure that the form and format of our outputs and activities will best serve the various communities with interests in EAR.

Our team has an **extensive track record**, with over a century of collective experience working on EAR and closely related issues, individually and through our history of successful collaboration. Our complementary expertise spans the key economic, technical, legal, and institutional elements that comprise the life cycle of EAR implementation, and does so with a deep history of producing applied research that contributes scholarly understanding and translational benefit to advance real-world applications.

We will leverage experience with EAR projects across the nation to a) develop a picture of the landscape through synthesis of existing information; b) expand this synthesis with new research results; c) develop tools and decision frameworks to fill key gaps; d) produce a unified EAR Lifecycle Map, a synthesis document that encapsulates the state of the practice for EAR into a roadmap for practitioners; and e) distill key messages about EAR into a suite of fit-for-purpose communication products that increase the reach of our outputs, supporting broader use of EAR approaches and thus increasing human and environmental well-being across the nation.

We conceptualize a life cycle view of EAR to encompass three interrelated and mutually supportive **pillars of decision making** for EAR: **geochemical and physical considerations; legal & institutional considerations; and cost-benefit analysis & life-cycle assessment**. Our **overarching hypothesis** is that through strategically combining applied research, decision-support innovations, and public engagement, we can lower barriers to widespread adoption of EAR and unlock EAR's potential to provide multiple water security benefits. For each pillar, we detail specific hypotheses and objectives in the sections below.

Because of the strength of our team's background and ongoing activity on EAR, our general approach to advancing each topic will be to **build directly on extensive ongoing efforts**, leveraging EPA support to a) generalize cutting edge research contributions, b) build and articulate conceptual bridges among currently siloed topics to produce a comprehensive picture of the life cycle of EAR implementation, and c) extend scholarly insights to create actionable recommendations for practitioners. The proposed program will develop and formalize best practices for EAR, using methods and approaches consistent with EPA's stated vision for research and engagement on this topic [13, 14]

## 2. Approach and Activities

### 2.1. Overview of methods and approach

Our overarching approach, illustrated in Figure 1, will rely on a knowledge-to-action framework [12, 15, 16] to combine research with knowledge translation, oriented specifically towards the implementation of EAR. Generically, a knowledge-to-action framework combines an iterative cycle of knowledge creation and action phases, each informed by the other [15]. A crucial component is the involvement of stakeholders, so that knowledge can be effectively tailored to the needs of those who will ultimately use or be affected by it. This engagement, ideally beginning at the research design phase, enables co-production of knowledge [17-21]. The ultimate goal is the successful development of tools that are useful, useable, and used, minimizing risk of 'reality disconnect' while still fostering academically interesting advances.

Our proposed program relies heavily on synthesis and communication of existing data, information, and knowledge with a target audience of decision makers contemplating EAR implementation. The program has a secondary component of primary research, oriented towards filling key gaps in available knowledge, and developing tools built on existing scholarly work.

The outcome of this process will be a national population of decision-makers with better understanding of, and better access to, their options for EAR and how to actualize them locally.

Our team's activities will be tailored for each pillar described below from the following general structure: 1) Literature review, informed by project team experience and expert elicitation, to identify key questions and information gaps; 2) case study research involving synthesis of published examples, unpublished detailed information from our previous work, document analysis, interviews with practitioners and stakeholders, and development of new case studies where key gaps are indicated; 3) engagement with our professional network and relevant organized public EAR networks (e.g., California Flood-MAR network; IAH-MAR network; NAWI Water-TAP); 4) qualitative methods including focus groups, interviews, document analysis, and expert elicitation to fill specific gaps and develop new information.

Our overarching goal to develop a combination of flexibly applicable tools and decision frameworks, the data to parameterize these tools in a general way (e.g., ranges of data for a particular field in the CBA tool), fact sheets and other materials for qualitative context, and guidance on refining options for specific situations faced by decision makers. Naturally, the blend of quantitative and qualitative methods, original research and synthesis, and tool development will be tailored for each pillar. Engagement with EAR practitioners, decision makers, and stakeholders be heavily emphasized throughout the project, as described in the community engagement section and outputs sections.

The three pillars as we define them are highly interrelated. We frame these pillars not as academic subjects, but as topics designed for investigation based on their relevance as direct inputs to decision making. As such, the pillars are organized to reflect a sequence of foundational questions decision-makers must answer: “Is it physically possible to use EAR in my local area?” precedes, “Is it legally permissible for me to implement EAR given local circumstances?”, and the affirmative details of each of these questions flow into the economic viability of EAR, leading to answers to questions such as “What path will results in the most cost-effective path to EAR implementation, who will benefit, and in what ways?”

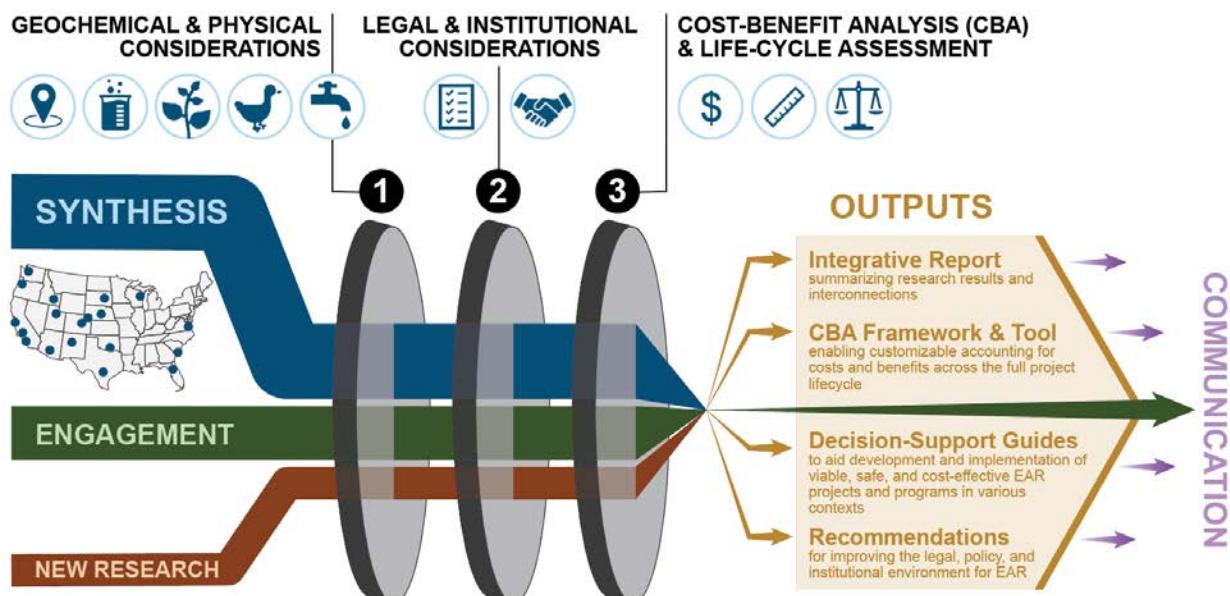


Figure 1: Conceptual illustration of our approach to this project. The ultimate outcome will be decision-makers with clearer understanding and better tools at their disposal for their local implementation of EAR.

## 2.2. Pillar 1: Geochemical and physical considerations

The first pillar for EAR decision making involves understanding and accounting for biogeochemical and physical factors that influence the selection, installation, and operation of suitable and effective sites and methods for EAR. EAR projects typically must consider, both as a matter of establishing project viability and in response to legal requirements (Pillar 2) and economic reality (Pillar 3), hydrogeology and water quality of aquifer system, site location, soil and vadose zone characteristics, water availability for EAR, source water quality, source water conveyance, and infrastructure and treatment needs.

We **hypothesize** that clarifying and communicating geochemical and physical guidance on three crucial topics will accelerate EAR implementation: (a) screening and evaluating potential sites, (b) conditions and processes needed to maintain operations, and (c) water quality. Motivated by this hypothesis, the project team will advance the following objectives and activities, orienting our work around *key questions for decision-makers and stakeholders*:

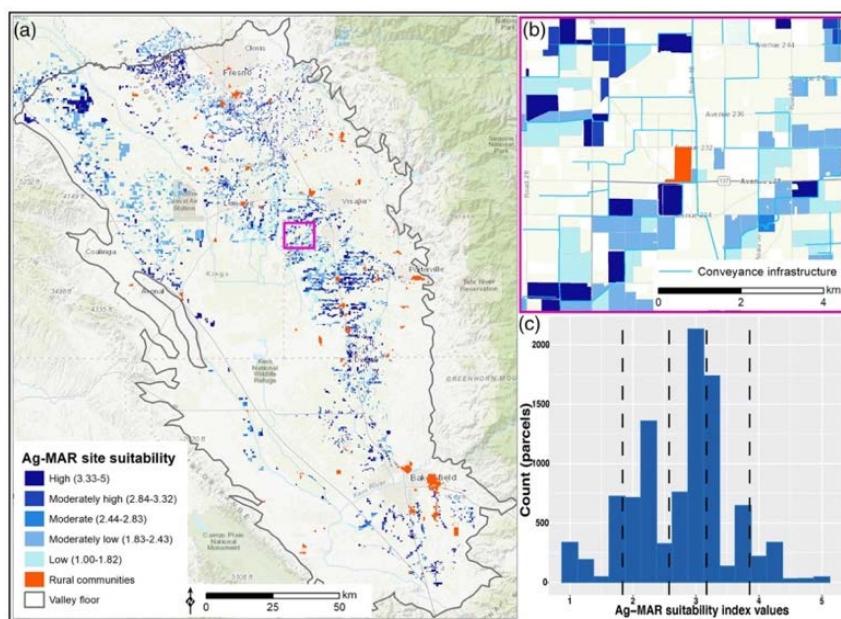


Figure 2: Example suitability map for EAR on agricultural land using flood flows ("Ag-MAR") based on physical, chemical, and social factors [1]. This kind of map is most useful within a GIS that allows display of multiple scales and/or areas, and ability to add/remove factors as desired. Inset map (b) shows area in pink rectangle from main map (a), including infrastructure available to route water.

Naturally, evaluating available source waters of various provenance is both a technical and legal matter (see Pillar 2 and [25]). We propose to 1) synthesize and summarize the range of decision support approaches to EAR site selection, highlighting their strengths, weaknesses, and the ideal contexts for application of each method, and 2) produce guidance for how EAR suitability mapping can help screen potential sites and focus subsequent field investigations.

Proposed research will address the lack of "standard" datasets, methods, and scales for EAR suitability analyses: projects and data availability vary greatly, so guidance on data sources and their likely relevance will be a useful step towards generalizing these methods. Recognizing intra-regional variability, we will focus on methods that include flexibility in choosing and weighting relevant factors and scales. The goal of this effort is to guide decision makers through

First, we will address foundational questions for EAR projects around **project siting**: *Where should an EAR project be located and what EAR method should be used?* Our team will build on its pioneering contributions to methods for evaluating and prioritizing potential EAR project sites [1, 22, 23]. Our team has pioneered decision support methods that combine geospatial biophysical datasets with socio-economic, legal and institutional data and auxiliary information such as stakeholder preferences, drinking water vulnerability, and community/ecosystem resilience [1, 22-24].

the choices and constraints that present bottlenecks to implementation of conceptually simple, but operationally challenging, "big-data" approaches to EAR site and method selection.

Second, we will address questions related to the installation, operation and management of EAR systems, including: *How much water is available for EAR from what sources, and how do we maintain project performance over its lifetime?* Informed operation and management of EAR systems is crucial to maintain overall system performance. EAR efficacy varies greatly based on regional and site-specific conditions, EAR method, and the nature of the water sources. For infiltration basins, soil clogging is a pernicious physical, chemical, and biological problem [e.g., 26]. For injection wells, carbonate clogging must be managed when the injectate is not sufficiently acidic [27]. These and other processes can result in reduced infiltration capacity or aquifer conductivity over time [28]. Mitigation can include physical maintenance of basin surfaces, and pre-treatment approaches like sediment detention, the choice of which depends on whether the source of the problem is, for example, sediment transported in source water or *in situ* erosion of basin walls. **We propose to link synthesis of this topic** with the decision support approach, focusing on assessment of factors most important to each major kind of EAR system. As many useful findings are in agency and contractor reports, considerable work will be required to identify and synthesize information beyond peer-reviewed sources.

Third, we will address water quality issues, driven by legal and regulatory requirements, and the need to preserve and support long-term aquifer health for a range of beneficial uses. Decision-maker questions will include: *What is the best option for EAR given the nature of the target aquifer and the available source waters?* EAR systems can have either positive or negative influences on water quality, with implications for human and environmental health. In general, high-quality source water is preferable, either diverted surface water or highly treated water from other sources. When recharged water quality is better than ambient groundwater, absent reactions release undesirable compounds, EAR may improve groundwater quality improvement through dilution [4, 29]. However, it is not always easy to find sufficient high-quality water for EAR. In practice, many potential surface water sources, soils, and or aquifers have the potential to result in groundwater contamination. Even when source water quality is high, soil and/or aquifer reactions can release geogenic (naturally occurring) compounds such as arsenic [30, 31] and other trace metals [32]. In some cases, EAR operators adjust source water chemistry to minimize the contaminant mobilization [33]. Recharging agricultural landscapes can mobilize salts, nitrate and pesticides residing in the vadose zone [34-37], or release other non-point source contaminants [38]. Microbial pathogens [39-41] and contaminants of emerging concern like PFAS also pose risks to human health, and have been linked to EAR [42, 43]. In addition, when non-traditional water sources are applied, with variable and/or unpredictable water quality, EAR systems have the potential to achieve quantitative water quality improvement during infiltration, including reducing concentrations of nitrate, organic compounds, and some pharmaceuticals [44-47]. **We propose to assimilate and synthesize a large literature** on these and related topics, and link risks and solutions to specific EAR methods, water sources, and field operations.

### 2.3. Pillar 2: Legal & institutional considerations

The second pillar of EAR decision making involves legal and institutional considerations, which we define broadly to include regulation, organizational structure and design, financing, and various processes that enable collaboration, outreach, and stakeholder involvement in service of EAR implementation. The legal and institutional context for decision making can motivate, enable, or impede EAR implementation and affect the technical and economic viability of

different approaches [48-50]. For example, each element of EAR—such as acquiring a source of water, conveying it to a recharge location, gaining land access, building and maintaining recharge facilities, infiltrating or injecting source water, monitoring and accounting for impacts and benefits, recovering stored water, and funding EAR activities—may be subject to legal controls [25]. However, these legal controls typically were not developed with EAR in mind, are often administered in siloed and fragmented ways, and can vary significantly from state to state [25]. Additionally, garnering sufficient political and financial support for an EAR project and successfully shepherding it through applicable permitting processes requires communication and collaboration among stakeholders with different priorities (e.g., water supply reliability, flood protection, habitat restoration, species protection), values, and resources (e.g., funding, land ownership, technical expertise, local knowledge) [51, 52]. Our extensive research on the legal landscape for EAR [25, 53-58] suggests the need for greater legal and regulatory clarity in many areas, and for guidance in effectively working within legal constraints. Case studies of particular EAR projects and programs by our research team [8] and others [59] indicate that navigating a complex patchwork of legal and institutional responsibility and stakeholder interests can be challenging for even sophisticated EAR proponents, but that viable pathways often exist for doing so.

We **hypothesize** that the legal and organizational context for EAR can strongly influence its costs and benefits, and that accessible, practical frameworks that help water managers, local stakeholders, and policymakers navigate—and improve—this context are needed to facilitate broader implementation of viable, safe, and cost-effective EAR.

The project team will collaborate with community partners and others to accomplish the following **objectives and activities**:

- (1) *Synthesize legal and organizational themes from EAR case studies* — Members of the project team have produced a pathbreaking [collection of case studies](#) focused on the institutional context and motivation for EAR projects around the country [8]. We propose to build on this work by synthesizing key legal and organizational takeaways from these and other case studies [e.g., 59], such as which governmental and private entities should be involved in developing and implementing EAR projects in different contexts, and in what ways. We will develop supplementary case studies to address key gaps identified through community engagement and the synthesis process, then fold the results into the EAR Lifecycle Map.
- (2) *Review key legal and policy context for EAR* — To complement thematic case study synthesis, we propose to build on our ongoing program of legal and policy research [25, 53-58] to examine laws and policies that motivate, enable, or impede EAR in a spectrum of U.S. jurisdictions. We will emphasize requirements or incentives for sustainable groundwater management and conjunctive use, rights to use or store water (including municipal wastewater and captured flood- or stormwater), permitting and regulatory compliance issues (e.g., related to water rights, water quality, species protections, and environmental review), constraints on or supports for EAR funding, and key areas of ambiguity or uncertainty that could affect EAR.
- (3) *Develop frameworks for effectively navigating the complex legal and organizational context for EAR projects and programs* — The thematic case study synthesis and legal review will inform development of decision-support frameworks that address a spectrum of motivating factors and objectives for EAR as well as key differences between legal jurisdictions, geographic settings (e.g., urban, agricultural, wildlands), EAR approaches, stakeholder engagement models, and other important variables. In addition to a decision-support

framework for those looking to implement individual EAR projects, we will produce a framework to help water agencies and other interested entities develop a programmatic approach to EAR. The latter will build on our ongoing work with Santa Clara Valley Water District as a case study to illustrate viability, and our prior work on institutional design for groundwater sustainability agencies in California [60, 61]. Crucially, we will focus on highlighting and clarifying incentive structures that motivate (or fail to motivate) EAR in the face of common pool resource challenges inherent to groundwater management [62, 63]. Our review will leverage our innovative work with Pajaro Valley Water Management Agency on Recharge Net Metering (ReNeM) as an incentive for distributed stormwater recharge [49], our studies of groundwater banking [64, 65], our work on the legal and policy context for local groundwater markets [58], and our series on addressing groundwater-surface water interactions [55, 57] in California. Finally, and relatedly, we will explore the meaning and operationalization of the concept of “multi-benefit” EAR itself, which is often used as justification, but has not been clearly and precisely articulated although it increasingly underpins policy and funding actions. While we will explore this topic here from a jurisdictional and stakeholder perspective, the topic, as with many others, has clear linkages to Pillars 2 and 3 as well.

- (4) *Generate recommendations for legal, policy, or institutional changes* policymakers could pursue to facilitate more extensive, effective, and affordable implementation of EAR.

Our methods will include a combination of literature review (drawing heavily on existing case studies by the project team and others), legal research, and additional or more in-depth case studies. Initial research will target a sample of jurisdictions with a spectrum of relevant characteristics and inform our selection of key legal, policy, and institutional questions. Interviews and virtual workshops with a broad range of EAR stakeholders will provide insights into legal and organizational barriers, opportunities, and ways of navigating them successfully, as well as potential changes policymakers could make to improve the legal and organizational context for EAR. Throughout, we will engage with community and non-academic partners and participants to refine research design and implementation, striving to co-produce all aspects of our research and outputs to ensure they are useful for and accessible to their audiences.

#### **2.4. Pillar 3: Cost-benefit analysis & life-cycle assessment**

The third pillar of decision making involves economic considerations. Cost-benefit analysis (CBA) is a foundational tool that allows project proponents like water agencies to evaluate potential investments for cost effectiveness, as often required by state and federal rule-making and funding processes. For example, regulatory changes to drinking water contaminant thresholds under the Safe Drinking Water Act §1412(b)(6) are subject to careful analyses of benefits and costs to ensure that changes are transparent, justified, and welfare-improving. As a result, CBA is, or should be, an essential component of informed decision-making.

In practice, decision makers often lack key data, and lack a guiding framework for integrating and analyzing these data. Costs and benefits of EAR projects are challenging to quantify: they vary across space, change over time, and are often site-specific. Quantifying capital, operations and maintenance (O&M), and other indirect costs and ancillary benefits across a project’s lifecycle is rarely done systematically. Despite calls for a generalized and comprehensive CBA framework, little research exists on the costs and benefits of EAR and the few past attempts to quantify elusive CBA components have not been aggregated, limiting their practical application and generalizability.

We **hypothesize** that 1) an effective CBA framework, parameterized with readily available data to account for local circumstances, would facilitate economically optimal decisions about EAR projects; 2) traditional CBA can be structured to evaluate the first-order economics of a potential EAR project from the perspective of project proponents and stakeholders; and 3) CBA can be extended to account for the full project lifecycle, including internalizing environmental effects and other externalities.

Our **research objectives** are to develop a generalized framework for CBA of EAR projects with customizable parameter ranges applicable for specific circumstances of proposed projects. This will both require input and perspective from Pillars 1 and 2, and in turn clarify economic dimensions of EAR proposals and inform decisions about project selection, siting, and operation (see Pillar 1) and legal and organizational viability (Pillar 2).

Our **approach** will involve the following: 1) evaluate specific user needs through structured engagement; 2) develop a generalizable CBA framework; 3) parameterize the framework with a data library; and 4) develop and disseminate accessible, generalizable tools for screening-level CBA of EAR projects.

First, we will co-produce the **design specifications** for a useful and useable CBA tool [66] by working directly with key decision makers in interviews and focus groups. We will leverage previous research by our team [67-71] and others on urban water and stormwater management, augmented by a survey of other existing costing and life-cycle analysis tools developed in related applications. We will identify and resolve critical data gaps or parameters with significant uncertainty, to the extent data sources exist or can be developed.

Second, we will **develop frameworks** for quantifying direct and ancillary economic costs and benefits of EAR projects. These frameworks will expand and generalize research our team is currently conducting in the Pajaro Valley, CA [72] (Figure 3). This Pajaro Valley project uses CBA to evaluate a set of novel incentives for EAR called Recharge Net Metering [49, 73-75]. We will leverage the detailed and unusually thorough data sets we have developed through this project, combining costs for capital investments and ongoing O&M for planning, permitting, construction, operation, and monitoring and management with a method to estimate direct and indirect benefits through interferences from user fees.

Preliminary conclusions reflect the utility of our approach for decision-making: Results are sensitive to project lifespan assumptions, a key question for natural infrastructure often deployed in EAR. Crucially, this cost-benefit analysis method in multi-party efforts can have vastly different results for the same project, depending on which entity's point of view is being modeled, with profound implications for program design and incentive structures (see also Pillar 2). Clarity borne of CBA could also enable multi-party agreements that aggregate funding sources or jointly finance multi-benefit EAR projects [51].

To incorporate environmental impacts associated with EAR to the CBA, we will inform this work with insights from life-cycle environmental assessment [76]. LCA can augment CBA with externalities ignored by traditional CBA, yet increasingly relevant to decision makers cognizant of the need for projects to serve multiple interests and deliver multiple benefits simultaneously (see also Pillar 2). For example, crucial, often-non-monetized costs and benefits can include environmental damage or long-term ecosystem health, the resilience benefits of decentralization and diversification of water supplies; energy and climate benefits from changes in groundwater levels, etc. We will quantify such environmental and social costs and benefits

using estimates from the environmental economics literature or estimate them using methods adapted from other water management studies [e.g., 77].

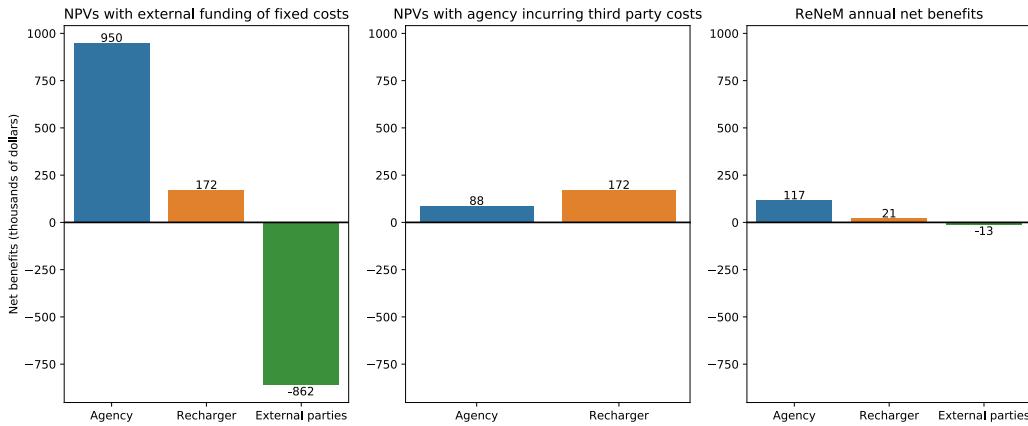


Figure 3: Preliminary CBA results for EAR in the Recharge Net Metering program, Pajaro Valley, CA [72]. Our analysis can reveal not only project costs, but also differences in perceived costs and benefits across different parties with interests in a single EAR project. This method thus has direct relevance for institutional incentives for EAR (see Pillar 2).

Third, we will **parameterize the CBA framework** with estimates and likely ranges for parameters across diverse EAR conditions. Drawing from the approach of our work in stormwater infrastructure [78], we will consolidate the best available data across a range of project types in a public database [79, 80]. A literature review will synthesize published empirical estimates from individual EAR projects [e.g., 52, 81], incorporate non-market valuation of water supplies [82], and quantify economy-level changes such as agricultural profits associated with recharge [83]. We will leverage unpublished data from detailed case studies developed by our research team [8], augmented by other technical literature. We will develop further data sources through analysis of technical literature, consulting reports, and unpublished data gained through interviews with local experts and managers. We will select case studies for diversity across factors including geography, source water, end use, and EAR method. Infrastructure and treatment costs will be adapted from existing open-source tools for related applications, including those Dr. Stokes-Draut has developed [69]. Results will be captured in the public database linked to the generalized CBA framework.

The final step will be to build an accessible, customizable, adaptable **open-source tool** that accounts for costs and benefits across the full EAR project lifecycle. The tools will contain a library of unit costs for infrastructure adaptable to different locations and scales using methods consistent with other EPA-funded costing tools (e.g., i-DST) [84]. The tool will calculate the levelized cost of water using customizable cost calculations that account for the project's location, construction date, expected operational life, size and capacity, site suitability, water quality requirements, and treatment train design, where applicable. Cost calculations will be consistent with federal cost analysis guidance [85]. Results will be reported as ranges for possible project costs that account for regional variability in costs and performance and uncertainty in future operating conditions due to climate change and will be validated against case study data. The tool will also provide first-order approximations of the life-cycle environmental impacts of with infrastructure construction, O&M, and end-of-life of recharge systems using methods developed by the team.

The tool will be developed in Excel and/or as an online tool, co-produced with stakeholder input and testing and directly informed by legal and institutional requirements surfaced through collaboration with Pillar 2 researchers. A set of recharge scenarios will be defined, described, quantified, and evaluated for sensitivity to key parameters to better understand the cost drivers under a range of conditions. These scenarios will be tested and illustrated through design charettes discussed below in Section 3.4, including, for example, the Arbuckle-Simpson aquifer in Oklahoma as one of the case studies. The scenarios will be provided as exemplars for others seeking to do CBA for groundwater recharge programs.

Ultimately, information from the tools and methods developed in Pillar 3 feeds back to Pillar 1, particularly through the potential to refine site selection based primarily on geochemical and physical factors.

In summary, this work will facilitate development of CBAs for future EAR by embedding economic costs and environmental impact quantification across the lifecycle into a broader CBA framework. The frameworks, tools, and examples will be available to users for screening potential EAR implementations.

### **3. Expected results, benefits, outputs, and outcomes**

Our results and outputs will all be primarily oriented towards audiences of decision-makers and stakeholders (e.g., water agency staff, regulators, relevant stakeholders, landowners, EAR project proponents, and consultants), in support of our ultimate goal of accelerated national adoption and diffusion of EAR, with water resource, economic, environmental, and social benefits as discussed elsewhere in this proposal.

Our outputs will be oriented around communication of results to these audiences, with a secondary emphasis on dissemination to academic audiences who can build on our findings.

Our primary capstone product will be an EAR Lifecycle Map, summarizing the results of and interconnections among all research components. Our goal is for this report to serve as a roadmap for decision-makers contemplating EAR projects, and a repository from which key resources and tools can be found and evaluated. This resource will be designed as accessible summary guidance that incorporates and highlights key guidance and lessons learned into a digestible by substantive report of reasonable length (60-100 pages), organized around the three pillars of our program. This synthesis report will be augmented by references to individual, deeper explorations that we surface through our literature review and produce for this project – as such, a key output from each of the three pillars will be crucial context on which the other research pillars can directly draw.

The EAR Lifecycle Map synthesis report and the specific outputs described below will be *accessible rather than encyclopedic*; our goal is to provide *useful resources for practitioners* in the field, while providing reference to and evaluation of more exhaustive sources. The synthesis report will also contain *recommendations for policymakers* with legal, policy, and institutional changes that could facilitate more extensive, effective, and affordable implementation of EAR at scale, which will be highlighted in the communications products described below.

#### **3.1. Pillar 1 Outputs: Geochemical and physical considerations**

Our key **geochemical and biophysical outputs** will include: Chapters in the *Lifecycle Map*; A *knowledge database* of geologic, water quality and physico-chemical criteria and their interaction and dependencies to be considered for different EAR types and human and environmental health concerns; a *guide to decision support* approaches for EAR site selection and suitability mapping; aggregation and evaluation of *geospatial biophysical datasets* for use in decision support tools;

and a suite of practical documents detailing EAR-related *water quality* criteria, potential contaminants and their sources, transport pathways and mobility.

### **3.2. Pillar 2 Outputs: Legal & institutional considerations**

Our **key legal, policy, and institutional outputs** will include: Chapters in the *Lifecycle Map*; *Decision-support guides*, in the form of a suite of practical documents that provide a framework to help water managers, consultants, and other stakeholders navigate the legal and organizational context for implementing EAR projects and programs, and *best practices for stakeholder engagement* and partnership to facilitate successful projects. In addition to these general guidance, we will produce several more targeted guides aimed at subsets of EAR decision making identified through our research and engagement activities (for example, assessments of specific legal issues, or decision trees focused on certain settings, such as urban, agricultural, or publicly managed non-agricultural lands).

### **3.3. Pillar 3 Outputs: Cost-benefit analysis & life-cycle assessment**

Our **key economics outputs** will include: Chapters in the *Lifecycle Map*; a generalizable, flexible, and comprehensive *CBA framework* to be used for EAR siting and implementation; parameterization of the CBA framework with a *database of values for cost and benefit components* including for environmental and community effects, and guidance for likely ranges across diverse EAR conditions and options; a *decision-making tool*, co-designed with stakeholders to maximize adoption potential, to support informed decisions and ultimately, lead to expanded adoption of optimal EAR projects.

Each of the three pillars will also publish research results in open access peer-reviewed journals to demonstrate validity and legitimacy among academic and consulting audiences.

We aim to provide water managers, consultants, policymakers, and local stakeholders with the accessible, practical information they need to navigate—and potentially improve—the information resources available on geochemical and biophysical considerations for EAR, contributing to broader implementation of viable, safe, and cost-effective EAR in coming years.

### **3.4. Integration & communication**

The capstone of our knowledge-to-implementation will lie in our efforts on overarching synthesis, integration, and communication. The primary effort for the bulk of Year 3 of this project will be focused on the following integration and outreach efforts, reflected also in the community engagement plan.

One engagement nexus for distilling and producing synthesis and communication outputs will be a major Symposium held in the final quarter of Year 2. Reprising and extending our successful Incentivizing Groundwater Recharge Symposium that we hosted in Berkeley, CA in September 2019 [86], the symposium will highlight research progress and enable learning from key practitioners. The symposium will focus on diversifying voices in the conversation around EAR through a scholarship program supported by intensive outreach. An explicit focus of the symposium proceedings will be workshopping and development of a “virtual road show.” This product will combine presentations distilling our research and outreach efforts, with real-world stories from thought leaders and successful implementers of EAR projects around the country who can personify the possibilities and pathways to EAR. This virtual road show will be developed and launched in Year 3.

Our EAR Lifecycle Map will be the central written integration that ties together insights generated and harvested during our research effort into a concise volume that provides a

roadmap for EAR implementation, targeted to decision makers and stakeholders. This synthesis, and the more detailed guidance, information, and tools it references for specific topics, will be developed with ongoing engagement.

We will organize one or more special conference sessions (e.g., BSMAR or NGRA) focusing on disseminating our work and those of key collaborators and leaders in the field.

Prior to the virtual road show, we will conduct one additional test of our package of tools and information. We will conduct approximately six virtual EAR selection and design charettes to test the methods we put together before their final release in Year 3. The potential EAR project proponents we solicit as volunteer participants will benefit from insights contributed by our team, and our outputs will gain the opportunity for field-testing and a final gap analysis.

Finally, in addition to more standard media outputs such as op-eds, blog posts, infographics, and fact sheets, we will develop video distillations of key outputs. Our experience with such video products [e.g., 87] suggests their effectiveness and importance for engaging with non-specialist audiences, and for drawing interested practitioners to more detailed resources.

Roadmaps and decision tools targeted at direct on-the-ground use will be published as publicly available reports and technical whitepapers, accompanied by freely available software products. All products, including video products and webcasts, will be freely online on a project website housed at UC Berkeley's Center for Law, Energy & the Environment and mirrored at co-PI institutions. Our efforts will be supported by exposure and outreach through social media, professional networks, and professional meetings.

Our team has a long and successful track record of tailoring outputs to the subject matter, audience, and goal outcomes. We will apply this experience to the full suite of outputs, but will also augment our efforts with design and communications professionals for full effect.

#### 4. Innovation

Water is an inherently interdisciplinary topic; thus, advancing EAR and its multi-benefit potential nationally will require not just the development of new approaches to technology and management practices, but also strategic communication and cross-cutting synthesis [8, 88].

The scholars comprising our team are leading innovators within their respective fields, as evidenced by publications in top, peer-reviewed and legal journals, regular consultation by implementing agencies, and frequent media interviews and citations. More importantly, team members have outstanding collaborative track records of multi- and interdisciplinary applied research that has directly influenced policy and management decisions [e.g., 56, 57, 60, 73, 75, 89-93]. Thus, the project's overarching innovation is its boundary-spanning nature and its outputs, which will dissolve silos to better-reflect the interconnections between EAR and other elements of water, environmental, social, and economic systems.

Our knowledge to implementation framework will ensure that innovative research is grounded in innovative practice. Research and tool development across the three research pillars will formalize and generalize emerging methods such as GIS-based site selection decision support tools, address knotty water quality concerns, apply emerging remote EAR site instrumentation methodology, develop novel incentive structures, and incorporate environmental impacts and benefits into Cost Benefit Analysis via life cycle assessment. Engagement and co-production will ground the syntheses and tools in decision-makers' needs. Further, by structuring the project around a unified Lifecycle Map of EAR and its supporting products, we will *enable broader applied innovation by others* through its real-world use.

Though each of the project's efforts—law, science, and economics—will be individually innovative, the project's central innovation will be its integration of science, law, and economics

research through planning, implementation, and management that builds connections across disciplinary boundaries. Impediments to broad incorporation and legitimization of EAR projects are often multidisciplinary barriers; thus, the convergence of multidisciplinary innovations will fill knowledge gaps, address multiple stakeholder needs, and provide generalizable guidance for EAR participants throughout the U.S.

## 5. Sustainability

The proposed work is predicated on the belief that an interdisciplinary research approach can produce a suite of solutions that promotes further deployment of EAR while concurrently addressing and ensuring three pillars of sustainability: social sustainability, economic sustainability, and environmental sustainability.

Environmentally, EAR projects can bolster the long-term sustainability of groundwater resources. Such projects improve the integrity of the groundwater resource while, if implemented thoughtfully, improving groundwater quality. More sustainable groundwater reserves also ensure the provision of a suite of ecosystem services [94, 95] and hydrologic system services [96] including supporting groundwater-dependent ecosystems, promoting surface water-groundwater connections, nutrient cycling, and flood management. Furthermore, EAR projects can integrate existing systems to collaboratively support water security [51], often at low cost.

The proposed work's interdisciplinary approach to EAR will synthesize traditionally siloed information to produce EAR support tools that are both accessible and scalable. These solutions will support all three pillars of sustainability. For instance, the team will seek extensive feedback from stakeholders to co-produce solutions that address community needs. This engagement will incorporate the voices of disadvantaged communities and underserved water systems in an effort, not only address their unique needs, but also to develop solutions that enable these communities and water systems to deploy more effective and inclusive EAR projects. More broadly, the decision support tools the proposed work plans to develop will support community efforts to sustainably plan and manage their water resources. Additionally, the incorporation of life cycle assessment will help the team produce a more sophisticated accounting of an EAR project—an accounting that appropriately quantifies the environmental, legal, and regulatory costs and benefits linked to EAR projects—so that communities across the country can use these decision support tools to develop effective, efficient, and economical EAR projects based on their local needs.

## 6. Project management

Leadership: Our team is uniquely placed to deliver on EPA's aims for advancing EAR. PI Michael Kiparsky has spent 20 years leading research and engagement efforts at the intersection of water institutions, science, economics, and law, including extensive work on enhanced aquifer recharge. He also has experience leading interdisciplinary, federally-funded research projects with multiple PIs involving human subject research. co-PI Andrew Fisher, co-PI Helen Dahlke, and co-PI Thomas Harter bring decades of nationally-recognized leadership in applied geochemical and physical considerations, and, crucially, deep expertise leading implementation of EAR projects. co-PI Ellen Bruno has deep expertise and experience in applied CBA, and will work with Jenn Stokes-Draut (technical advisor) to integrated LCA. Dave Owen (co-PI) is a leading scholar of water, land-use, and environmental law, with specific expertise in legal elements of groundwater recharge.

Expertise: Beyond its impressive leadership panel, this team includes researchers with strong backgrounds in life-cycle assessment (Jennifer Stokes-Draut [UCB and LBNL]), land-use

principles, climate adaptation, inclusive decision-making (Louise Bedsworth [UCB]), institutional innovation, regulatory analysis, and water governance (Nell Green Nylen [UCB] & Molly Bruce [UCB]). Members of this team also have extensive histories of fruitful collaboration, a joint productivity demonstrated through numerous successful projects together. Crucially, the team has previously collaborated on interdisciplinary projects that blend the physical, economic, and institutional understandings of EAR. As interdisciplinary scholars, team members understand, both based on academic insights and on long experience, that effective interdisciplinary outcomes are by necessity the result of far more than a list of disparate departments and specialties on a page. Rather, selection of a team that has interest, experience, and a thirst for truly boundary-spanning work can make the difference between a funded collection of individual outputs (i.e., interdisciplinarity by stapler) versus investment that results in a coherent whole.

**Management:** Though the project will enjoy the benefits of interdisciplinarity, researchers will spearhead different portions of the project's three research pillars based on their primary expertise (Figure 4); co-PI Fisher, co-PI Dahlke, and co-PI Harter will cooperatively lead examination of geochemical and physical considerations. co-PI Owen will lead examination of legal and institutional considerations. co-PI Bruno and PI Kiparsky will cooperatively lead examination of cost-benefit analysis and life-cycle assessment. PI Kiparsky will lead overall project management, ensuring that each pillar remains on track toward success and that necessary cross-pollination between these pillars is occurring, that the project remains on-budget, and that quality assurance is maintained. co-PI Fisher will assist in QA/QC. Project work will engage both named, key personnel and additional research personnel to be identified and hired.

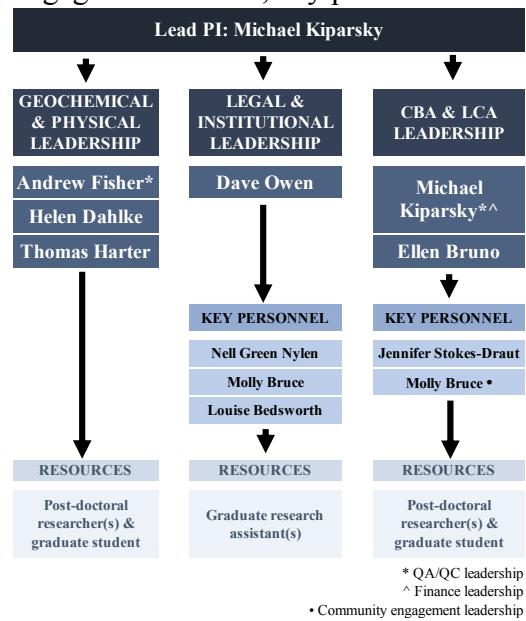


Figure 4: Project leadership structure.

(instruments, glassware, etc.). UCSC is a Hispanic Serving Institution, is one of the youngest UC campuses, and has notable centers of excellence in (among other programs) genomics, Earth and planetary sciences, linguistics, and video game design.

UCD - The University of California, Davis has extensive facilities for field and laboratory research (Russell Ranch, UCD Student Farm, Interdisciplinary Center for Inductively-

Coupled Plasma Mass Spectrometry, Stable Isotope Facility, Analytical Laboratory), high-performance computing (Farm Cluster), the NIFA/NSF-funded Artificial Intelligence Institute for Next Generation Food Systems, and over 100 years of experience in Cooperative extension, stakeholder outreach, and information dissemination to communities. UCD researchers on this team also have extensive connections to state, local and federal water and regulatory agencies which we will leverage for the proposed work.

UCB - The Center for Law, Energy & the Environment at UCB School of Law has extensive facilities for convening events as well as a 15-year history of successfully organizing and facilitating workshops, conferences, focus groups, and other meetings. This experience, and the related intellectual infrastructure of the UC Berkeley Campus, are key resources on which we will draw heavily to complete the proposed work.

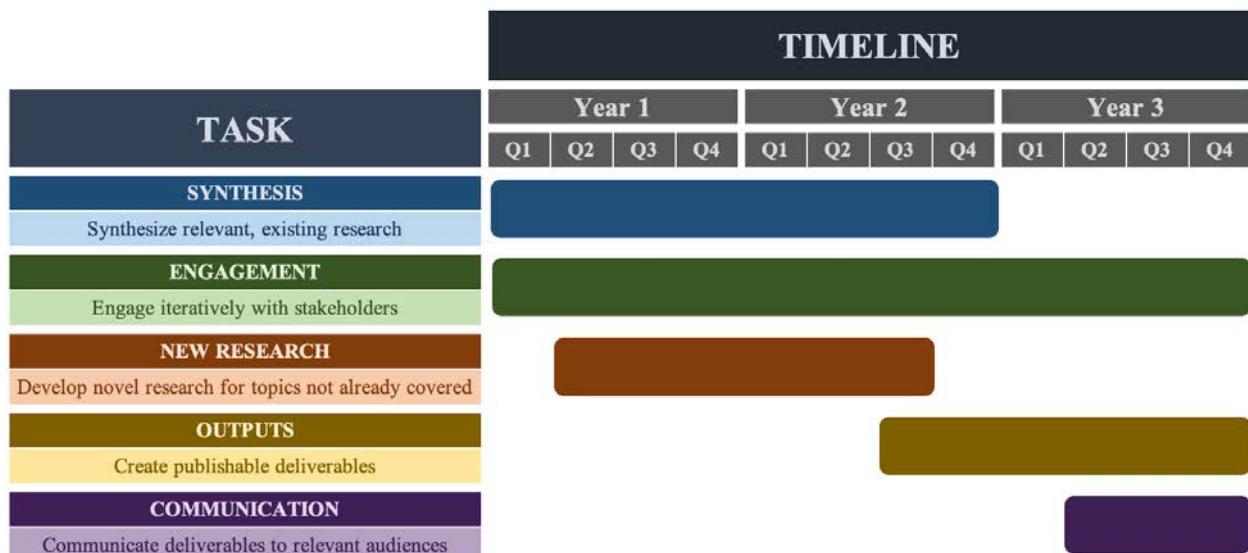


Figure 5: Project timeline and milestones.

## 7. Conclusion

We have proposed a knowledge-to-implementation framework for Enhanced Aquifer Recharge. We believe our proposal not only responds to EPA's clear call for intellectual and practical leadership and action on EAR, but that it does so in ways that expand this vision to be greater than the sum of its parts. This is fitting, as the additive set of outputs and outcomes in our proposal are consistent with the recognized need for knowledge generation that is grounded in engagement, and targeted towards practical, on the ground implementation outcomes.

Producing such products is, and has been, central goals for the research and engagement programs of all our team members – it is on this deep and ongoing foundation that we propose to build an integrated whole that will enable our work and the work of others in this field to drive true, lasting, and impactful change at a national scale.

The proposed work's interdisciplinary, knowledge-to-action framework will enable communities across the country to understand, advocate for, and actualize environmental, economic, and public health benefits of EAR projects while using and advancing socially inclusive frameworks for deployment and management of multi-benefit EAR projects.

## Quality Assurance Statement

### Quality Assurance Overview

The application team is familiar with EPA expectations and standards for Quality Assurance (<https://www.epa.gov/quality/agency-wide-quality-program-documents> and linked documents) and is prepared to meet all requirements. That said, the primary basis for the proposed work is assessment of existing information and studies, and development of a research framework and simple tools for life cycle analysis, assessment of institutional requirements and bottlenecks, and calculating the magnitude and nature of economic costs and incentives. Some of this information is available in the peer-reviewed literature, where analytical standards are documented and research practices aid in assurance of data quality. However, for older studies in particular, it can be difficult to demonstrate repeatability given historical limitations in the amount and kind of detailed information concerning sample collection, laboratory processing, survey data, and analytical standards. In addition, field samples from operating hydrologic systems can't be replicated, and journal papers rarely include levels of detail found in lab notebooks and listings of standard operating procedures that permit complete recapitulation of analyses. As a consequence, projects of this kind must work with a range of available information, including results from earlier studies completed with a range of methods and standards. In particular, much of the data generated by and available to water agencies, non-governmental organizations, and stakeholders was collected under conditions that limited opportunities for a research-grade QA/QC program. This does not mean that data from water agency studies, management plans, and contractor reports is not helpful or can't be used, but it does require clear and nuanced assessment of data sources, methods for collection, and the basis for interpretation. We will do this.

We will also be prepared for the possibility that modest hydrologic data could be collected during the last phase of the proposed project period, when several existing contracts have ended, to aid in assessment of EAR system performance.

Additionally, we will gather information on legal and institutional considerations for EAR through interviews and stakeholder convenings. QA/QC and data management for these aspects of the project will be governed by Institutional Review Board requirements, to be determined as described in the Human Subjects Research Statement.

### Quality Assurance Leadership and Procedures

PI Kiparsky will be the primary Quality Assurance Manager for the proposed project, overseeing QA/QC activities for the team, with support from Co-PIs having expertise in particular areas. For example, Co-PI Fisher will oversee QA/QC for synthesis and integration of assessments of EAR geochemical and physical factors and performance, including analysis of new hydrologic data, if any, associated with active EAR systems (e.g., mass balance calculations). There will be regular leadership meetings by teleconference among the PI and Co-PIs, and QA/QC will be a standing agenda item to be updated at least once per quarter while the project is operating.

In general, secondary data will be collected from existing peer-reviewed papers and book chapters, agency and contractor reports, online databases (national, state, and local), and other documents as may be revealed through archival activities. Metadata will be assembled for all data sources (as described in the Scientific Data Management Plan), and data plus metadata will be assembled as part of regular project activities for uploading to a public repository. For

technical data not subject to provisions in our Human Subjects Research Protocol, newly acquired data (for example, metadata resulting from discussion with agency staff and stakeholders) will be documented with information on date, time, venue, and key words. We expect that most archival data will be from the last 20-30 years, but there may be older sources used, and data can come from essentially any geographic region. It is likely that many more sources will be assessed than will be included in formal analysis, and we will document how decisions are made concerning inclusion of individual data sources.

Copies of key documents in PDF format will be stored on a central GoogleDrive or Box folder organized by topic and region, with additional identifiers and keywords recorded on a GoogleSheet at the top of the folder structure that will allow search of these materials. The complete archive folder will be password protected for use by project personnel.

Additional QA topics related to human subjects research will be detailed in our Human Subjects Research Protocol, which is subject to review and approval by the UC Berkeley Institutional Review Board.

## Human Subjects Research Statement

The proposed research includes potential human subjects research associated primarily with Legal & Institutional Considerations to assess the legal and organizational context for EAR in a spectrum of jurisdictions across the nation and co-produce both frameworks for effectively navigating this context and recommendations for improving it. Prior to beginning any human subjects work, refined plans for the proposed research will be submitted for review to the Institutional Review Board (IRB), the Committee for Protection of Human Subjects, for the University of California, Berkeley (FWA00006252; IRB00000455 and IRB00005610).

### 1. Risk to Human Subjects

#### a. Human Subjects Involvement, Characteristics, and Design

To expand the implementation of viable, safe, and cost-effective EAR, we need a better understanding the legal and organizational context for EAR implementation, including the often-crucial role of communication and collaboration among local stakeholders with different priorities, values, and resources. Our qualitative research takes a mixed methods approach to assessing this context and co-producing decision-support tools and recommendations that includes the following potential human subjects research:

- Interviews with knowledgeable parties to aid the development of supplemental case studies of the legal and institutional dimensions of EAR.
- Stakeholder convenings (workshops) with a spectrum of EAR stakeholders from across the country.

Participants in interviews and workshops will provide critical insights—that could not be derived in other ways—into key legal and organizational barriers, opportunities, and ways of navigating them successfully and into potential policy changes at the federal, state, or local level that could improve the legal and organizational context for EAR going forward.

Interview and workshop participants will be selected for their involvement in decision making for EAR, their role as stakeholders who will be affected by EAR projects or programs, or their involvement in community advocacy with underrepresented communities that may be affected by EAR. They will include stakeholders and decision makers associated with water and wastewater utilities (e.g., utility managers and high-level staff), consultants, technical service providers, state and federal water quality regulators, community advocates from underserved communities, NGOs, landowners, and other entities that might pursue EAR or be affected by it.

Interviews will be focused on supplemental case studies targeted to address gaps in knowledge about the legal and organizational context for EAR, including key gaps in geographic or jurisdictional representation identified through literature review, legal research, and synthesis. Workshops will include participants from across the United States. Academic team members will identify potential interviewees and workshop participants in collaboration with community research partners and key informants, through publicly available information, and via snowball sampling. We will engage community / non-academic team members / partners throughout to ensure that the design, implementation, and analysis of the research meets the needs of potential users and beneficiaries.

All research participants will be adults (age 18 and older), some of whom will be from economically vulnerable populations. The participation of socioeconomically vulnerable groups will contribute critical perspectives that are too often excluded from water decision making. These perspectives will be crucial for helping us to understand the legal and organizational context for EAR—including the priorities, values, and resources of socioeconomically vulnerable stakeholders—and how to expand viable, safe, and cost-effective EAR implementation that helps meet their needs and concerns.

#### **b. Sources of Materials**

Interviews will be conducted by phone or Zoom depending on the participant's preference. Workshops will be conducted by Zoom. Collected material from interview and workshop participants will include researchers' notes and audio/video recordings that will be used to aid in data transcription and/or checking notes for accuracy. For Zoom interviews and workshops, we will use the UC Berkeley-licensed version of Zoom and adhere to the UC Berkeley best practices and guidance for Zoom security, including keeping the software up-to-date, using a password-protected meeting code, not allowing others to join before the host, and not allowing others to screen share. We will only do local recordings onto the computer (not Cloud recordings) from Zoom. Participants' personal information (name, organizational affiliation, contact information) will be omitted or anonymized in reporting of results. Data will be secured on a password protected computer and backed up to secure cloud-based service(s) as described in the Scientific Data Management Plan. Data will be shared through a secure platform as described in the Scientific Data Management Plan, and accessible to only relevant researchers on the project team approved to conduct Human Subjects Research. All data will be destroyed 5 years after resulting publications.

#### **c. Potential Risks**

There is minimal risk in this study in which interviewees and workshop participants will describe and reflect on their personal and/or professional experiences and views related to the legal and organization context for EAR, which is not considered a sensitive topic. It is possible that, due to the specific nature of this project, although individual identities will be kept anonymous, participants might be identifiable to knowledgeable persons in the field.

### **2. Adequacy of Protection Against Risks**

To minimize potential risks to interview and workshop participants, an Information Letter will clearly state, and the interviewer will remind the interviewee at the start of the interview, that confidentiality cannot be guaranteed due to the unique nature of each institution's experience. Participants will be informed about the following elements, at a minimum: a) The identity/affiliation of the researchers; b) A clear description of the study procedures; c) A statement that participation in the research is voluntary; d) Contact information for questions about the research. Participants will also be informed that their name, contact information, and any other identifying information will be kept confidential and that research results will not include a list of interview participants and will not link any identifying information to quotes or any other data, unless they specifically grant permission for it. Audio/video recording will be conducted only if interviewees / workshop participants agree to be audio/video recorded at the beginning of the interview or workshop. Participants will be given the opportunity to review

their own quotes and contributions to final publications and will be asked how they should be identified in any publications. They will also be given the opportunity to withdraw their information any time prior to publication of results.

There is a possibility that data privacy could be breached if, e.g., the researcher's computers are hacked, revealing participants answers to interview questions or contributions to workshop discussions. We expect the magnitude of potential harm associated with such a breach would be minimal, since interviews and workshops will not be designed to elicit sensitive information and would not put participants at risk of any civil or criminal liability.

### **3. Potential Benefits of the Proposed Research to Human Subjects and Others**

Interview and workshop participants could benefit by developing a better understanding of the legal and organizational context for EAR and how to navigate that context more effectively. Underserved communities in particular could benefit from guidance on improving coordination among and within organizations with different interests to support EAR that helps meet multiple community needs. Workshop participation will provide opportunities for members of underrepresented groups and decision makers at regulatory agencies, water utilities, and other stakeholder organizations to form networking relationships with each other. These relationships may serve as a point of entry for people from marginalized groups to be meaningfully included in future decision making for EAR, as well as for decision makers to have access to the valuable perspectives of community members from marginalized groups.

The potential benefits for research participants outweigh the potential risks associated with participation in this study. The risks to participants are reasonable because we expect the risks of a potential breach of confidentiality to be minimal while participants may gain knowledge that could help their communities, or help them in their work.

### **4. Importance of the Knowledge to be Gained**

Navigating the complex patchwork of institutional responsibility, legal coverage, stakeholders, and potentially competing priorities can be challenging for even sophisticated EAR proponents. Because the legal and organizational context for EAR can strongly influence its costs and benefits, accessible, practical frameworks that help water managers, local stakeholders, and policymakers navigate—and improve—this context are needed to facilitate broader implementation of viable, safe, and cost-effective EAR.

Interviews and workshops will give academic researchers and collaborating partners insights into the legal and institutional context for EAR and how to navigate it effectively. Resulting publications and other outputs will convey these insights widely, providing critical, accessible information to decision makers and stakeholders that can accelerate widespread implementation of effective and affordable EAR that improves water security and sustainability across the nation.

The risks to research participants are reasonable because we expect the risks of a potential breach of confidentiality to be minimal while we expect to gain knowledge of great interest and utility to academics, potential implementers of EAR, and the many stakeholders potentially affected by decisions about whether, where, and how to implement it.

## Scientific Data Management Plan

### SDMP Goal and Platform

The overall data management goal for the proposed project is to ensure that all distribution products (e.g., journal articles, presentations, white papers), data, and metadata generated in association with this work are archived in a stable repository so that they remain secure and publicly accessible for the long term. We propose to accomplish this using the Dryad Digital Repository (<https://datadryad.org/stash>), co-developed with the California Digital Library. Dryad infrastructure is robust, redundant, standards compliant, flexible, persistent (with DOI and ORCID identifiers) and features a searchable and discoverable structure that assures community access for decades into the future. Other platforms, as listed below, will also be employed at various stages of the project.

### Data Collection

The team will collect: (1) Metadata throughout all data categories and types, described below; (2) Maps and diagrams indicating locations where samples and data were collected; (3) Hydrogeologic data: workflow for analysis, overall EAR system performance, water levels, flow rates, precipitation, mass balance; (4) Geochemical data: workflow for analysis, sample metadata, sample analytical results; (5) Microbiological data: workflow for analysis, sample metadata, tabulated results from DNA/RNA analyses.

Data will be collected in the following formats: (1) Text and tables, generated from word processor and spreadsheet; (2) Maps and diagrams indicating locations where samples and data were collected, generated with ArcGIS, Illustrator, Acrobat and other programs, saved as separate PDFs; (3) Hydrogeologic data: text (ASCII) format; (4) Geochemical data: text (ASCII) format; (5) Microbiological data: text (ASCII) format, if possible - depending on file sizes, some of the genomics data may be saved in binary (standard) formats used for processing.

### Documentation and Metadata

Metadata and documentation will include the following: 1) Details of experimental or modeling protocols and methods; 2) Analytical and statistical methods employed; 3) Definitions of variables, vocabularies, units of measurement, any assumptions made, and the format and file type of the data; 4) Who created or contributed to the data, its title, date of creation and under what conditions it can be accessed; 5) Additional details will be included as appropriate - all efforts will be made to include sufficient metadata such that a third party researcher can recreate analyses from raw data. Metadata will be recorded in or appended to original data files where possible, and where not possible will be included in separate documents clearly indicated in the original data files or protocols.

### Copyright and Intellectual Property Rights (IP/IPR) issues

Data collected will be considered to be in the public domain once initial publication of results has taken place. Thus, we anticipate no copyright, licensing, or restrictions on third party reuse of data. The only exception we foresee to this related to technical data is where privacy considerations require anonymizing details, masking specific geographic location (e.g., obscuring location to prohibit tracing data to a specific parcel of land), or other IRB-related considerations.

### Storage and Backup Plan

*Short term* (as project is developed and run): GoogleDrive, Box.com, and File Stream, to make data and other work accessible to the project team. Data will be password protected and restricted to project team members and key collaborators, until evaluation of any privacy

considerations has been conducted and data are suitable to release publicly, per the above sections. Backups and data security will be conducted to the standards of the above mentioned service providers, which have been approved by University of California IT services. *Long term* (beginning in first project year, continuing to and beyond project completion): California Digital Library using Dryad ([datadryad.org](http://datadryad.org)).

Data sharing, access, security

*Short term* (as project is developed and run): project team will work mainly from a shared GoogleDrive or Box.com folder (with subfolders by topic, purpose, and time). These services automatically back up data to the cloud, and synchronize files and access. This space will be password protected and accessible only to selected project team members. *Long term*: a subset of data will become accessible to the public when uploaded to CDL/Dryad, which will be done in association with preparation and publication of technical reports, theses, and papers. Much of this will occur near the end and after the proposed work period – we anticipate that all data generated by the project that is to be made public being accessible within 12 months of project completion. Any data deemed private and sensitive will be scrubbed and deleted securely by the time the project sunsets, which we anticipate would be within 12 months of project end date. All relevant data will be deposited to Dash, the Data Publication platform, and preserved in the backend Merritt Repository for both public access and long-term storage upon completion of the project study. All relevant data will be made publicly available upon deposit and will be findable through a DataCite DOI granted by Dash. <https://dash.ucop.edu>

The only anticipated restrictions on long-term data sharing will flow from Institutional Review Board requirements, to be determined as described in the Human Subjects Research Statement.

Responsibilities and Resources

Data Management for this project is to be the primary responsibility of PI Kiparsky, with assistance from Co-PIs Fisher, Dahlke, and Harter. Kiparsky will work with the Co-PIs to prepare and upload data, and will make sure they are able to complete this work if Kiparsky is not able to do so. Data status and archiving will be a standing agenda topic of standard meetings between the PIs and the full project team. The project team takes this Data Management seriously and considers associated steps to be primary, critical expectations and milestones for the project. Novel data generation will be a modest part of the project relative to synthesis of existing data and engagement, dissemination, and communication efforts, and staff time budgeted for proposed activities will be sufficient to cover data management.

Project team members, and particularly co-PI Fisher, have significant experience with data management methods proposed in this Data Management Plan. Additional expertise is available as needed for technical support through IT departments the respective collaborating institutions. Use of the California Digital Library, Dryad, Dash, and Merritt Repository is covered by Indirect Costs. No additional hardware or software beyond that budgeted in the project or pre-existing in respective research groups will be required to support the Data Management Plan.

## Community Engagement Plan

Our entire research and engagement proposal is based around a knowledge to action framework, steeped in co-production of knowledge through engagement with decision makers and stakeholders. Our proposed project includes qualitative research that draws upon the expertise and perspective of interested parties as subjects. Thus, this community engagement plan reflects, and is reflected by, the proposal as a whole. Further, there are tight linkages between this Community Engagement Plan and our Human Subjects Research Statement.

*What we plan to do and why it will help:* The proposed knowledge-to-action framework will engage with communities and stakeholders in several crucial ways: (1) in the process of synthesizing existing research, the team may find gaps that need to be filled with novel research, the bulk of which will involve direct outreach to communities and regulators whose work is tangential to EAR; (2) the team's decision-support tools and recommendations will be co-produced through extensive outreach and by seeking feedback from potential users of such decision-support tools and targets of such recommendations; (3) the team will conduct outreach-style community engagement centered around communication of deliverables; and (4) the outputs and associated products from this work are primarily targeted towards practitioners and community members, and thus are themselves both based on, and a form of, community engagement.

These categories of community engagement will take the form of targeted ***semi-structured interviews*** with a broad range of EAR experts and interested parties in order to aid synthesis and development of supplemental case studies; larger ***workshop-style stakeholder convening events*** with regulators, those they regulate, and community members; a ***symposium*** meant to highlight the team's research progress while also providing an additional opportunity for stakeholder input and feedback; media outreach and networking; and a range of ***synthesis and communication products*** including a ***video distillation*** of the decision-making toolkit and recommendations developed by the team. The intent of these interviews and workshops is to procure information on EAR's existing legal and organizational contexts and to solicit ideas for how to improve these legal and organizational contexts while the broad intent of the symposium and video distillation is to communicate lessons learned.

Interviewees and workshop participants will include decision makers associated with water and wastewater utilities (e.g., utility managers and high-level staff), consultants, technical service providers, state and federal water quality regulators, community advocates from underserved communities, community advocates from communities that may be impacted by EAR (e.g., Leadership Counsel for Justice and Accountability, the Community Water Center, and Self-Help Enterprises), NGOs, landowners, organized public EAR networks (e.g., California Flood-MAR network; IAH-MAR network; NAWI Water-TAP), and other entities that might pursue EAR or be affected by its proliferation.

We will make particular effort to include recognized experts, but also to broaden participation to include voices that may not always have an opportunity to influence emerging conversations like this one. We will seek input from disadvantaged community representatives and members of underrepresented ethnic and racial groups with relevant interests in our qualitative sampling. Further, we will actively recruit them to join in conversations such as our Symposium as participants and speakers, and will offer our scholarship program to cover their costs. Recruitment will happen through our networks, including our connections with relevant NGOs and organizations at our universities.

Engagement with broader communities of EAR stakeholders is essential to the project's success because, through their formal and informal participation, they will provide insights not available by other means which will in turn have a direct impact on the quality and utility of the deliverables the team provides. Furthermore, participation of socioeconomically vulnerable groups is essential to the project's success because it will contribute critical perspectives that are too often excluded from water decision making. These perspectives will be crucial for helping us to understand the legal and organizational context for EAR—including the priorities, values, and resources of socioeconomically vulnerable stakeholders—and how to expand viable, safe, and cost-effective EAR implementation that helps meet their needs and concerns.

It is also our hope that interviewees and workshop participants will personally benefit from participation in this project by developing a better understanding of the various contexts that influence the proliferation of EAR projects and how to navigate the complexities inherent in those various contexts. It is also our intent that underserved communities in particular will benefit from guidance on improving coordination among and within organizations with different interests to support EAR that helps meet multiple community needs. Workshop participation will provide opportunities for members of underrepresented groups and decision makers at regulatory agencies, water utilities, and other stakeholder organizations to form networking relationships with each other. These relationships may serve as a point of entry for people from marginalized groups to be meaningfully included in future decision making for EAR, as well as for decision makers to have access to the valuable perspectives of community members from marginalized groups.

This interview- and workshop-style approach is also helpful because it will ensure that the form and format of the proposed outputs will best serve the various communities with interests in EAR. By engaging with communities and stakeholders as early as the research design phase of the project, our team will have the opportunity to co-produce knowledge in an effort to develop a more successful suite of tools and recommendations.

Equally essential is that we translate the project's research outcomes into assessible, practitioner-oriented materials that are then actively disseminated. This process of active dissemination will include production of video-based communication tools so that research outcomes are digestible, even to non-expert and non-practitioner audiences. Our experience with such video products suggests the effectiveness and importance for engaging with non-specialist audiences, and for drawing interested practitioners to our more detailed resources.

*How we will coordinate outreach:* To ensure that community engagement remains a central tenet of the proposed work, PI Kiparsky will ensure that it is a component of each bi-monthly full-team meeting so that team members have the support and accountability to proactively address potential concerns and develop more robust engagement methods. Likewise, PIs Fisher, Harter, Owens, Bruno, and Dahlke will ensure that community engagement discussions are also a component of each bi-weekly pillar-specific meeting. More broadly, frequent communication will be crucial to ensure effective multi-way feedback mechanisms and accountability across objectives and between project researchers.

*Why we can do it successfully:* This team is well-poised to undertake these community engagement and outreach efforts successfully. We know this from deep and consistent experience.

Team members also have ongoing and enduring engagement with various EAR practitioners in the Central Valley, along California's Central Coast, and in Northern California as well as active projects in these regions. This engagement is evidenced by the proposed work's

letters of support which serve as a small sample of entities with which we have close connections. Further, two of our three campuses (UCD & UCSC) are Minority Serving Institutions or Hispanic Serving Institutions with strong traditions of involving Latinx, Asian American, Native American, and Pacific Islander students.

The convening power of our team and our institutions has proven to be very strong over the years – people tend to respond to our invitations to engage, not only because of the prestige associated with our universities, but because we put tremendous effort into thoughtful topic selection and framing of our conversations, projects, and events.

This convening power is a crucial point. We are clearly a California-centric team, approaching a nationally-relevant topic. This is intentional. Our team made a conscious choice to prioritize our proven interdisciplinary chemistry and the depth of our collective expertise, neither of which we believe can be easily assembled for any given proposal without the benefit of deep collective experience. Critically, we do not believe this is a disadvantage for the purposes of engagement or broad relevance. We collectively have vast and deep networks in the field of EAR and water and environmental resources generally. And, speaking frankly, people listen and respond to our invitations for participation in research projects we design and conduct. Our engagement will be national in scope, and effectively so.

We previously held a fruitful symposium with broad national representation titled Incentivizing Groundwater Recharge Symposium in Berkeley, California in September, 2019. This high profile event resulted in a multi-state exchange, and the production of our case study collection on which we will build insights for the proposed work. This symposium illustrates a large capacity for engagement, on which we will draw directly, and which is described in the following text.

Our team members have a long and successful history of convenings-based research. At the Center for Law, Energy & the Environment alone, our water program has conducted dozens of joint research and engagement projects over the past 10 years, many of which have involved other members of this research team as co-conveners or participants. We have honed methods for carefully building workshops through balanced invitation lists, including careful attention to various axes of diversity in our attendees. We have extensive facilitation and moderation skills and experience across a range of group sizes, methods, goals, approaches, and outcomes for convening-based projects.

In general, our convening-based projects have two main outputs: the first is the conversation itself, which is designed to raise the conceptual bar for all involved by encouraging open and sometimes provocative exchanges and generation of ideas. The second output is typically a synthesis report. These reports, typically targeted towards decision makers, capture key ideas from the facilitated discussion, and augment them with our own research to produce products that are relevant and digestible, while also being credible, robust and academically legitimate. These products of engagement not only advance thinking within the communities from which our participants bring their views, but also typically both include and are targeted towards decision makers such as agency staff and elected officials.

The impact of these projects is also reflected in a consistent history of placing project-related Op-Eds in papers of record, and drawing public interest reflected in interviews and quotations in a range of media outlets. Outcomes from these efforts have included direct influence on state agency actions [56], clarification of legal and regulatory ambiguity [56], new legislation [97] and legislative implementation [98], state budget decisions [89], and governance and management actions [60], to point to just a few selected examples of impacts.

Ultimately, we are extremely well poised to engage, and have built our project and knowledge-to-action framework around meaningful engagement and the co-production of knowledge in support of EAR implementation. Community engagement in this project will be a strength and contribution in and of itself, but will also contributes to the overarching goals for the project. These goals, in the end, are ultimately to the benefit of communities nationwide, as the result of enabling EAR implementation.

## References

1. Marwaha, N., G. Kourakos, E. Levintal, and H.E. Dahlke, *Identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities*. Water Resources Research, 2021. **57**(3): p. e2020WR028811.
2. Cuthbert, M., T. Gleeson, N. Moosdorf, K.M. Befus, A. Schneider, J. Hartmann, and B. Lehner, *Global patterns and dynamics of climate–groundwater interactions*. Nature Climate Change, 2019. **9**(2): p. 137-141.
3. Maliva, R.G., *Managed aquifer recharge: state-of-the-art and opportunities*. Water Science and Technology: Water Supply, 2015. **15**(3): p. 578-588.
4. Dillon, P., P. Stuyfzand, T. Grischek, M. Lluria, R. Pyne, R. Jain, J. Bear, J. Schwarz, W. Wang, and E. Fernandez, *Sixty years of global progress in managed aquifer recharge*. Hydrogeology journal, 2019. **27**(1): p. 1-30.
5. Casanova, J., N. Devau, and M. Pettenati, *Managed aquifer recharge: an overview of issues and options*. Integrated groundwater management, 2016: p. 413-434.
6. Council, N.R., *Prospects for managed underground storage of recoverable water*. 2008: National Academies Press.
7. Gale, I. and P. Dillon, *Strategies for Managed Aquifer Recharge (MAR) in semi-arid areas*. 2005: UNESCO Paris.
8. Miller, K., A. Milman, and M. Kiparsky, *Introduction to the Special Collection: Institutional Dimensions of Groundwater Recharge*. Case Studies in the Environment, 2021. **5**(1): p. 1245648.
9. Ringleb, J., J. Sallwey, and C. Stefan, *Assessment of managed aquifer recharge through modeling—A review*. Water, 2016. **8**(12): p. 579.
10. Lacher, L.J., D.S. Turner, B. Gungle, B.M. Bushman, and H.E. Richter, *Application of hydrologic tools and monitoring to support managed aquifer recharge decision making in the upper San Pedro River, Arizona, USA*. Water, 2014. **6**(11): p. 3495-3527.
11. Bekele, E., B. Patterson, S. Toze, A. Furness, S. Higginson, and M. Shackleton, *Aquifer residence times for recycled water estimated using chemical tracers and the propagation of temperature signals at a managed aquifer recharge site in Australia*. Hydrogeology journal, 2014. **22**(6): p. 1383-1401.
12. Kiparsky, M., A. Milman, and S. Vicuña, *Climate and Water: Knowledge of Impacts to Action on Adaptation*. Annual Review of Environment and Resources, 2012. **37**(1): p. 163-194.
13. US EPA, *Life-cycle analysis to support cost-effective enhanced aquifer recharge*. 2021, US Environmental Protection Agency: Washington, DC. p. EPA-G2022-STAR-C1.
14. US EPA. *WRAP Action 7.4: Increase Understanding of Current Aquifer Storage and Recovery Practices*. 2021; Available from: <https://www.epa.gov/waterreuse/national-water-reuse-action-plan-online-platform?action=7.4>.
15. Graham, I.D., J. Logan, M.B. Harrison, S.E. Straus, J. Tetroe, W. Caswell, and N. Robinson, *Lost in knowledge translation: time for a map?* Journal of continuing education in the health professions, 2006. **26**(1): p. 13-24.
16. Field, B., A. Booth, I. Ilott, and K. Gerrish, *Using the Knowledge to Action Framework in practice: a citation analysis and systematic review*. Implementation Science, 2014. **9**(1): p. 1-14.

17. Djenontin, I.N.S. and A.M. Meadow, *The art of co-production of knowledge in environmental sciences and management: lessons from international practice*. Environmental Management, 2018. **61**(6): p. 885-903.
18. Jasanoff, S., *States of knowledge: the co-production of science and the social order*. 2004: Routledge.
19. Lemos, M.C. and B.J. Morehouse, *The co-production of science and policy in integrated climate assessments*. Global environmental change, 2005. **15**(1): p. 57-68.
20. Lemos, M.C., J.C. Arnott, N.M. Ardooin, K. Baja, A.T. Bednarek, A. Dewulf, C. Fieseler, K.A. Goodrich, K. Jagannathan, and N. Klenk, *To co-produce or not to co-produce*. Nature Sustainability, 2018. **1**(12): p. 722-724.
21. Mach, K.J., M.C. Lemos, A.M. Meadow, C. Wyborn, N. Klenk, J.C. Arnott, N.M. Ardooin, C. Fieseler, R.H. Moss, and L. Nichols, *Actionable knowledge and the art of engagement*. Current Opinion in Environmental Sustainability, 2020. **42**: p. 30-37.
22. O'Geen, A.T., M.B.B. Saal, H.E. Dahlke, D.A. Doll, R.B. Elkins, A. Fulton, G.E. Fogg, T. Harter, J.W. Hopmans, C. Ingels, F.J. Niederholzer, S.S. Solis, P.S. Verdegaaal, and M. Walkinshaw, *Soil suitability index identifies potential areas for groundwater banking on agricultural lands*. California Agriculture, 2015. **69**(2): p. 75-84.
23. Russo, T.A., A.T. Fisher, and B.S. Lockwood, *Assessment of managed aquifer recharge site suitability using a GIS and modeling*. Groundwater, 2015. **53**(3): p. 389-400.
24. Sallwey, J., J.P. Bonilla Valverde, F. Vásquez López, R. Junghanns, and C. Stefan, *Suitability maps for managed aquifer recharge: A review of multi-criteria decision analysis studies*. Environmental Reviews, 2019. **27**(2): p. 138-150.
25. Owen, D., *Law, Land Use, and Groundwater Recharge*. Stanford Law Review, 2021. **73**(5).
26. Bouwer, H., *Artificial recharge of groundwater: hydrogeology and engineering*. Hydrogeology journal, 2002. **10**(1): p. 121-142.
27. US EPA. *Aquifer Recharge and Aquifer Storage and Recovery*. N.D. ; Available from: <https://www.epa.gov/uic/aquifer-recharge-and-aquifer-storage-and-recovery>.
28. Martin, R., *Clogging issues associated with managed aquifer recharge methods*, IAH Commission on Managing Aquifer Recharge. 2013.
29. Waterhouse, H., T. Broadhead, A. Massell, H. Dahlke, T. Harter, and D. Mountjoy, *Management considerations for protecting groundwater quality under agricultural managed aquifer recharge*. 2021, Sustainable Conservation. p. 39 pp.
30. Fakhreddine, S., J. Dittmar, D. Phipps, J. Dadakis, and S. Fendorf, *Geochemical triggers of arsenic mobilization during managed aquifer recharge*. Environmental science & technology, 2015. **49**(13): p. 7802-7809.
31. Erban, L.E., S.M. Gorelick, H.A. Zebker, and S. Fendorf, *Release of arsenic to deep groundwater in the Mekong Delta, Vietnam, linked to pumping-induced land subsidence*. Proceedings of the National Academy of Sciences, 2013. **110**(34): p. 13751-13756.
32. Torkzaban, S., J. Vanderzalm, S. Treumann, and T. Amirianshoja, *Understanding and quantifying clogging and its management during re-injection of CSG water permeates, brines and blends, Final Report*. 2015, CSIRO, Australia.
33. Fakhreddine, S., H. Prommer, S.M. Gorelick, J. Dadakis, and S. Fendorf, *Controlling arsenic mobilization during managed aquifer recharge: The role of sediment heterogeneity*. Environmental Science & Technology, 2020. **54**(14): p. 8728-8738.

34. Dahlke, H. and T. Kocis, *Streamflow availability ratings identify surface water sources for groundwater recharge in the Central Valley*. California Agriculture, 2018. **72**(3): p. 162-169.

35. Bachand, P., S. Roy, N. Stern, J. Choperena, D. Cameron, and W. Horwath, *On-farm flood capture could reduce groundwater overdraft in Kings River Basin*. California Agriculture, 2016. **70**(4): p. 200-207.

36. Bachand, P.A., S.B. Roy, J. Choperena, D. Cameron, and W.R. Horwath, *Implications of using on-farm flood flow capture to recharge groundwater and mitigate flood risks along the Kings River, CA*. Environmental science & technology, 2014. **48**(23): p. 13601-13609.

37. Dahlke, H.E., G.T. LaHue, M. Mautner, N.P. Murphy, N.K. Patterson, H. Waterhouse, F. Yang, and L. Foglia, *Managed aquifer recharge as a tool to enhance sustainable groundwater management in California: examples from field and modeling studies*. Advances in chemical pollution, environmental management and protection, 2018. **3**: p. 215-275.

38. Rodvang, S. and W. Simpkins, *Agricultural contaminants in Quaternary aquitards: A review of occurrence and fate in North America*. Hydrogeology Journal, 2001. **9**(1): p. 44-59.

39. Taylor, J., K.m. Lai, M. Davies, D. Clifton, I. Ridley, and P. Biddulph, *Flood management: Prediction of microbial contamination in large-scale floods in urban environments*. Environment International, 2011. **37**(5): p. 1019-1029.

40. Jiang, S.C., K.-Y. Lim, X. Huang, D. McCarthy, and A.J. Hamilton, *Human and environmental health risks and benefits associated with use of urban stormwater*. WIREs Water, 2015. **2**(6): p. 683-699.

41. Dillon, P., S. Toze, D. Page, J. Vanderzalm, E. Bekele, J. Sidhu, and S. Rinck-Pfeiffer, *Managed aquifer recharge: Rediscovering nature as a leading edge technology*. Water Science and Technology, 2010. **62**(10): p. 2338-2345.

42. Page, D., J. Vanderzalm, A. Kumar, K.Y. Cheng, A.H. Kaksonen, and S. Simpson, *Risks of perfluoroalkyl and polyfluoroalkyl substances (PFAS) for sustainable water recycling via aquifers*. Water, 2019. **11**(8): p. 1737.

43. Cáñez, T.T., B. Guo, J.C. McIntosh, and M.L. Brusseau, *Perfluoroalkyl and Polyfluoroalkyl substances (PFAS) in Groundwater at a Reclaimed Water Recharge Facility*. Science of The Total Environment, 2021: p. 147906.

44. Beganskas, S., G. Gorski, T. Weathers, A.T. Fisher, C. Schmidt, C. Saltikov, K. Redford, B. Stoneburner, R. Harmon, and W. Weir, *A horizontal permeable reactive barrier stimulates nitrate removal and shifts microbial ecology during rapid infiltration for managed recharge*. Water research, 2018. **144**: p. 274-284.

45. Vymazal, J., *Removal of nutrients in various types of constructed wetlands*. Science of the total environment, 2007. **380**(1-3): p. 48-65.

46. Valhondo, C., J. Carrera, C. Ayora, I. Tubau, L. Martinez-Landa, K. Nödler, and T. Licha, *Characterizing redox conditions and monitoring attenuation of selected pharmaceuticals during artificial recharge through a reactive layer*. Science of the Total Environment, 2015. **512**: p. 240-250.

47. Valhondo, C., L. Martinez-Landa, J. Carrera, C. Ayora, K. Nödler, and T. Licha, *Evaluation of EOC removal processes during artificial recharge through a reactive barrier*. Science of the total environment, 2018. **612**: p. 985-994.

48. Nylen, N.G., *Surface Water Quality Regulation as a Driver for Groundwater Recharge: The Case of Virginia's Sustainable Water Initiative for Tomorrow*. Case Studies in the Environment, 2021. **5**(1): p. 1124592.

49. Miller, K., A.T. Fisher, and M. Kiparsky, *Incentivizing Groundwater Recharge in the Pajaro Valley Through Recharge Net Metering (ReNeM)*. Case Studies in the Environment, 2021. **5**(1): p. 1222393.

50. Reddy, K.R. *Enhanced Aquifer Recharge*. 2008. Dordrecht: Springer Netherlands.

51. Pecharroman, L.C., C. Williams, N.G. Nylen, and M. Kiparsky, *How can we govern large-scale green infrastructure for multiple water security benefits?* Blue-Green Systems, 2021. **3**(1): p. 62-80.

52. Perrone, D. and M. Merri Rohde, *Benefits and Economic Costs of Managed Aquifer Recharge in California*. San Francisco Estuary and Watershed Science, 2016. **14**(2).

53. Fritz, K. and N. Green Nylen, *Water Right Permitting Options for Groundwater Recharge: Avoiding Unintended Consequences*. 2020: Legal Planet. p. <https://legal-planet.org/2020/07/27/water-right-permitting-options-for-groundwater-recharge-avoiding-unintended-consequences/>.

54. Fritz, K. and N. Green Nylen, *When Does a Groundwater Recharge Project NOT Need a Water Right?* 2020: Legal Planet. p. <https://legal-planet.org/2020/08/03/when-does-a-groundwater-recharge-project-not-need-a-water-right/>.

55. Owen, D., A. Cantor, N.G. Nylen, T. Harter, and M. Kiparsky, *California groundwater management, science-policy interfaces, and the legacies of artificial legal distinctions*. Environmental Research Letters, 2019. **14**(4): p. 045016.

56. Miller, K., N. Green Nylen, H. Doremus, D. Owen, and A. Fisher, *When Is Groundwater Recharge a Beneficial Use of Surface Water in California?* . 2018, Center for Law, Energy & the Environment, University of California. p. 8 pp.

57. Cantor, A., D. Owen, T. Harter, N. Green Nylen, and M. Kiparsky, *Navigating Groundwater-Surface Water Interactions Under the Sustainable Groundwater Management Act*. 2018, Center for Law, Energy & the Environment, University of California, Berkeley. p. 50 pp.

58. Green Nylen, N., M. Kiparsky, K. Archer, K. Schnier, and H. Doremus, *Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act*. 2017, Center for Law, Energy & the Environment, University of California at Berkeley: Berkeley, CA. p. 90 pp.

59. UNESCO, *Managing Aquifer Recharge: A Showcase for Resilience and Sustainability*. 2021. p. <https://unesdoc.unesco.org/ark:/48223/pf0000379962.locale=en>.

60. Kiparsky, M., D. Owen, N.G. Nylen, B. Cosen, H. Doremus, A. Fisher, J. Christian-Smith, and A. Milman, *Designing Effective Groundwater Sustainability Agencies: Criteria for Evaluation of Local Governance Options*. 2016, Center for Law, Energy & the Environment, University of California at Berkeley: Berkeley, CA. p. 64 pp.

61. Kiparsky, M., A. Milman, D. Owen, and A.T. Fisher, *The importance of institutional design for distributed local-level governance of groundwater: The case of California's Sustainable Groundwater Management Act*. Water, 2017. **9**(10): p. 755.

62. Ostrom, E., *Governing the Commons: The Evolution of Institutions for Collective Action*. 1990, Cambridge: Cambridge University Press.

63. Blomquist, W., E. Schlager, and T. Heikkila, *Common Waters, Diverging Streams: Linking Institutions and Water Management in Arizona, California, and Colorado*. 2004: Resources for the Future.

64. Kiparsky, M., K. Miller, P. Goulden, A. Milman, and D. Owen, *Groundwater recharge for a regional water bank: Kern Water bank, Kern county, California*. Case Studies in the Environment, 2021. **5**(1): p. 1223400.

65. Milman, A., C. Bonnell, R. Maguire, K. Sorensen, and W. Blomquist, *Groundwater Recharge for Water Security: The Arizona Water Bank, Arizona*. Case Studies in the Environment, 2021. **5**(1): p. 1113999.

66. Dilling, L. and M.C. Lemos, *Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy*. Global environmental change, 2011. **21**(2): p. 680-689.

67. Stokes, J.R. and A. Horvath, *Energy and air emission effects of water supply*. 2009, ACS Publications.

68. Stokes, J.R. and A. Horvath, *Supply-chain environmental effects of wastewater utilities*. Environmental Research Letters, 2010. **5**(1): p. 014015.

69. Miara, A., Talmadge, M., Sitterley, K., Evans, A., Huang, Z., Macknick, J., McCall, J., Kurup, P., Akar, S., Van Allsburg, K. and Stokes-Draut, J., *The Water Technoeconomic Assessment Pipe-Parity Platform (WaterTAP3)*. 2021, National Renewable Energy Lab.(NREL): Golden, CO.

70. Hogue, T.S., C.D. Bell, E. Gallo, K. Spahr, E. Grubert, J.R. Stokes-Draut, and J.E. McCray. *Advancing tools for holistic management of water resources: Development of an integrated decision support tool (i-DST) for grey and green infrastructure implementation*. in *AGU Fall Meeting Abstracts*. 2018.

71. Bell, C.D., K. Spahr, E. Grubert, J. Stokes-Draut, E. Gallo, J.E. McCray, and T.S. Hogue, *Decision making on the gray-green stormwater infrastructure continuum*. Journal of Sustainable Water in the Built Environment, 2019. **5**(1): p. 04018016.

72. Sherman, L., M. Bruce, A. Fisher, M. Kiparsky, and E. Bruno, *Distributing costs & benefits of Recharge Net Metering (ReNeM) to sustain and improve groundwater resources*. in preparation.

73. Pajaro Valley Water Management Agency, *Memorandum RE: Informational Item 12C: Consider Approval of a Proposal to Establish Recharge Net Metering (ReNeM) as a Pilot Program for Five Years, Acting General Manager, March 10, 2016*. 2016.

74. Fisher, A.T., C. Coburn, M. Kiparsky, B.S. Lockwood, M. Bannister, K. Camara, and S. Lozano. *Recharge net metering to incentivize sustainable groundwater management*. in *AGU fall meeting abstracts*. 2016.

75. Kiparsky, M., A.T. Fisher, W.M. Hanemann, J. Bowie, R. Kantor, C. Coburn, and B. Lockwood, *Recharge net metering to enhance groundwater sustainability*. 2018, Center for Law, Energy & the Environment, UC Berkeley School of Law: Berkeley, CA.

76. Corporation, S.A.I. and M.A. Curran, *Life-cycle assessment: principles and practice*. 2006, National Risk Management Research Laboratory, Office of Research and ....

77. Spahr, K.M., C.D. Bell, J.E. McCray, and T.S. Hogue, *Greening up stormwater infrastructure: Measuring vegetation to establish context and promote cobenefits in a diverse set of US cities*. Urban Forestry & Urban Greening, 2020. **48**: p. 126548.

78. Green Nylen, N. and M. Kiparsky, *Accelerating Cost-Effective Green Stormwater Infrastructure: Learning from Local Implementation*. 2015, Wheeler Institute for Water Law & Policy, University of California at Berkeley School of Law: Berkeley, CA. p. 35.

79. Ross, A. and S. Hasnain, *Factors affecting the cost of managed aquifer recharge (MAR) schemes*. Sustainable Water Resources Management, 2018. **4**(2): p. 179-190.

80. Arshad, M., J.H. Guillaume, and A. Ross, *Assessing the feasibility of managed aquifer recharge for irrigation under uncertainty*. Water, 2014. **6**(9): p. 2748-2769.

81. Giannmar, D.E., D.M. Greene, A. Mishrra, N. Rao, J.B. Sperling, M. Talmadge, A. Miara, K.A. Sitterley, A. Wilson, and S. Akar, *Cost and Energy Metrics for Municipal Water Reuse*. ACS ES&T Engineering, 2021.

82. Maliva, R.G., *Economics of managed aquifer recharge*. Water, 2014. **6**(5): p. 1257-1279.

83. Hanak, E., A. Escriva-Bou, B. Gray, S. Green, T. Harter, J. Jezdimirovic, J. Lund, J. Medellín-Azuara, P. Moyle, and N. Seavy, *Water and the future of the San Joaquin Valley*. Public Policy Institute of California, 2019. **100**.

84. Shojaeizadeh, A., M. Geza, J. McCray, and T.S. Hogue, *Site-Scale Integrated Decision Support Tool (i-DSTss) for Stormwater Management*. Water, 2019. **11**(10): p. 2022.

85. EPA, U., *US. Guidelines for preparing economic analyses*. . 2014, US Environmental Protection Agency,: Washington, DC, . p. EPA 240-R-00-003.

86. Center for Law, E.t.E. *Inventivizing Groundwater Recharge: A Berkeley Law Symposium*. 2019. Berkeley, CA, September 10, 2019, <https://sites.law.berkeley.edu/recharge-2019/>.

87. UCTV. *Recharge Net Metering (ReNeM)*. Recharge Net Metering (ReNeM). 2020; Available from: <https://www.uctv.tv/sustainable-cal/search-details.aspx?showID=36130>.

88. Kallis, G., M. Kiparsky, A. Milman, and I. Ray, *Glossing Over the Complexity of Water*. Science, 2006. **314**(5804): p. 1387c-1388.

89. Kiparsky, M., K. Miller, R. Roos-Collins, E. Roos-Collins, and D. Rademacher, *Piloting a Water Rights Information System for California*. 2021, Center for Law, Energy & the Environment at UC Berkeley School of Law Berkeley, CA. p. 122 pp.

90. Harter, T., J. Lund, J. Darby, G.E. Fogg, R. Howitt, K.K. Jessoe, and G.S. Pettygrove, *Addressing nitrate in California's drinking water*. With a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Davis, CA: UC Davis Center for Watershed Sciences, 2012.

91. Kocis, T.N. and H.E. Dahlke, *Availability of high-magnitude streamflow for groundwater banking in the Central Valley, California*. Environmental Research Letters, 2017. **12**(8): p. 084009.

92. Pauloo, R.A., A. Escriva-Bou, H. Dahlke, A. Fencl, H. Guillon, and G.E. Fogg, *Domestic well vulnerability to drought duration and unsustainable groundwater management in California's Central Valley*. Environmental Research Letters, 2020. **15**(4): p. 044010.

93. Ghasemizade, M., K.O. Asante, C. Petersen, T. Kocis, H.E. Dahlke, and T. Harter, *An integrated approach toward sustainability via groundwater banking in the southern Central Valley, California*. Water Resources Research, 2019. **55**(4): p. 2742-2759.

94. Daily, G.C., S. Polasky, J. Goldstein, P.M. Kareiva, H.A. Mooney, L. Pejchar, T.H. Ricketts, J. Salzman, and R. Shallenberger, *Ecosystem services in decision making: time to deliver*. Frontiers in Ecology and the Environment, 2009. **7**(1): p. 21-28.

95. Daily, G., *What are ecosystem services*. Global environmental challenges for the twenty-first century: Resources, consumption and sustainable solutions, 2003: p. 227-231.

96. Fisher, A.T., *Groundwater Provides and Receives Hydrologic System Services*. *Groundwater*, 2015. **53**(5).
97. Kiparsky, M. and J.F. Hein, *Regulation of Hydraulic Fracturing in California: A Wastewater and Water Quality Perspective*. 2013, Wheeler Institute for Water Law & Policy, University of California, Berkeley: Berkeley, CA. p. 61.
98. Cantor, A., M. Kiparsky, R. Kennedy, S. Hubbard, R. Bales, L.C. Pecharroman, K. Guivetchi, C. McCready, and G. Darling, *Data for Water Decision Making: Informing the Implementation of California's Open and Transparent Water Data Act through Research and Engagement*. 2018.

## BUDGET JUSTIFICATION

### PERSONNEL

Name	Position/Title	Annual Salary	% Time	Year 1	Year 2	Year 3	Total
Michael Kiparsky	PI	\$138,000	25%	\$34,500	\$34,500	\$34,500	\$103,500
Louise Bedsworth	Program Director	\$163,600	10%	\$16,360	\$16,360	\$16,360	\$49,079
Nell Green Nylen	Research Fellow	\$91,600	35%	\$32,060	\$32,060	\$32,060	\$96,180
Molly Bruce	Research Fellow	\$65,200	50%	\$32,598	\$32,598	\$53,240*	\$118,436
Postdoc 1 TBD	Postdoc	\$65,292	100%	\$65,292	\$65,292		\$130,584
Postdoc 2 TBD	Postdoc	\$65,292	100%		\$65,292		\$65,292
Kevin Quach	Program Administrator	\$59,508	5%	\$2,975	\$2,975	\$2,975	\$8,926
PhD Student TBD	Graduate Student	\$88,826	49%*		\$54,850	\$56,496	\$111,346
<b>Total</b>				<b>\$183,785</b>	<b>\$303,927</b>	<b>\$195,631</b>	<b>\$683,343</b>

\*See descriptions for explanation of differences in salary and time by year.

#### **Michael Kiparsky (PI)**

Michael Kiparsky, Director of the CLEE Wheeler Water Institute, will serve as project director, and project lead for the efforts led by CLEE. He will work on intercampus exchange between other researchers and engagement with external stakeholders, supervise the efforts of CLEE's project team, participate in research efforts, and oversee synthesis and communications efforts.

#### **Louise Bedsworth**

Louise Bedsworth, Land Use Program Director at CLEE, will lead efforts involving integrating land use and project siting into EAR. She will conduct legal, regulatory, institutional and technical analysis, and supervise work by Research Fellows.

#### **Nell Green Nylen**

Nell Green Nylen, Senior Research Fellow at the Wheeler Water Institute at CLEE, will focus on qualitative research on the project. She will conduct legal, regulatory, institutional and technical analysis, and participate in writing and engagement with subject matter experts.

#### **Molly Bruce**

Molly Bruce, Research Fellow at the Wheeler Water Institute at CLEE, will focus on qualitative research on the project. She will conduct legal, regulatory, institutional and technical analysis,

and participate in writing and engagement with subject matter experts. Ms. Bruce will contribute 50% effort in Years 1&2, and 82% in Year 3 of this project.

#### **Postdoctoral Scholar 1 (TBD)**

We will hire an interdisciplinary post-doctoral scholar or research fellow to focus on a range of semi-quantitative and qualitative research tasks, including data gathering and analysis on the geophysical synthesis and contributions to other topic areas (e.g., infrastructure cost estimates or cost-benefit modeling). In addition to conducting technical analysis, the scholar will participate in writing and engagement with subject matter experts. This postdoc will be jointly supervised by members of the leadership team as appropriate for the specific topics of focus.

#### **Postdoctoral Scholar 2 (TBD)**

This postdoc will work on life-cycle cost and environmental accounting and tool development. This postdoc will be supervised by Dr. Stokes-Draut and will only be working in year 2.

#### **Kevin “Kiki” Quach**

Kevin Quach, Program Administrator at CLEE, will assist with research tasks and meeting organization.

#### **PhD Student (TBD)**

We will hire a graduate student to focus on a range of quantitative research tasks, including data gathering and analysis of costs and benefits. In addition to conducting technical analysis, the scholar will participate in writing and engagement with stakeholders. The student will contribute 49% effort during the academic year (4.41 months), and 100% during the 3 summer months in Year 2 and 3. We are assuming a 3% inflation rate for this position due to past annual union increases for graduate students. This student will primarily be advised by Dr. Bruno with additional collaborative input from Dr. Stokes and other members of the research team as appropriate.

#### **FRINGE BENEFITS**

Position/Title	Fringe Rate %	Year 1	Year 2	Year 3	Total
PI	35.9%	\$12,386	\$12,386	\$12,386	\$37,157
Program Director	35.9%	\$5,873	\$5,873	\$5,873	\$17,619
Research Fellow	35.9%	\$11,509	\$11,509	\$11,509	\$34,529
Research Fellow	35.9%	\$11,703	\$11,703	\$19,113	\$42,519
Postdoc 1	14.4%	\$9,402	\$9,402		\$18,804
Postdoc 2	14.4%		\$9,402		\$9,402
Program Administrator	43.8%	\$1,303	\$1,303	\$1,303	\$3,910
Graduate Student	2.6%		\$1,426	\$1,469	\$2,895
<b>Total</b>		<b>\$52,176</b>	<b>\$63,004</b>	<b>\$51,654</b>	<b>\$166,834</b>

## Travel

Expenses are mainly for airfare, mileage, and other transportation to/from field sites, public and technical meetings, and visits with collaborating agencies/groups (water supply, resource conservation, NGO, regulatory, etc.). Trip dates and destinations will be determined in conjunction with stakeholders, and are subject to COVID-19 considerations.

Travel for each year will include 1) attendance for selected team members at EPA STAR Progress Reviews and the EPA STAR Final Workshop; 2) presentation of results at a national water management meeting with target audience of decision-makers, regulators, consultants, and scholars (e.g., BSMAR, NGWA); 3) travel for periodic collaboration meetings among team members and for engagement with local and regional regulators and agency decision makers.

A travel budget of \$19,806 (\$6,602 each year) is requested for these purposes.

Purpose	Location	Item	Computation	Cost
EPA STAR Progress Review	Washington, DC	Lodging	4 people x \$150/night x 2 nights	\$1,200
		Airfare	4 people x \$500 round trip	\$2,000
		Per diem	4 people x \$62/day	\$248
		Local transport	3 people x \$125	\$375
National water management conference	TBD	Lodging	1 person x \$150/night x 2 nights	\$300
		Airfare	1 person x \$500 round trip	\$500
		Per diem	1 person x \$62/day	\$62
		Local transport	1 person x 125	\$125
		Registration fees	\$500	\$500
Regional site visits and collaboration	Within California	Mileage	12 trips x 184 miles x \$0.585/mile	\$1,292
<b>Total annual travel</b>				<b>\$6,602</b>

A separate trip in year two will include \$2,000 for one domestic water industry conference (e.g., the AWWA ACE event) where this research will be disseminated.

Purpose of Travel	Location	Item	Computation	Cost
Water industry-focused conference to present project outcomes for dissemination	TBD	Registration	1 person x \$650	\$ 650
		Lodging	1 person x \$190/night x 3 nights	\$ 570
		Airfare	1 person x \$500 roundtrip airfare	\$ 500
		Meals	1 person x \$70/day x 4 days	\$ 280
		Total		\$ 2,000

## Supplies

### Computer

A laptop computer will be purchased for the Postdoctoral Scholar (\$2,500).

## Other

### Design and Publication

These costs include graphic design and printing of project whitepapers and other communication materials. Journal publication includes author charges for open access publication. Graphic design budget includes fees for graphic design services, potentially including report layout, infographics, or other communications materials. The budget in year three includes funds for a barrage of fact sheets, infographics, explainers, and other outputs targeted towards building understanding and support for EAR among practitioners, decision-makers, and lay stakeholders.

Year 1: One open-access journal article at \$2,000 [geophysical and technical data synthesis]

Year 2: One open-access journal article @ \$2,000 and two whitepapers @\$1,000/each.

Year 3: Two open-access journal articles @\$2,000/each; one whitepaper @1,000. Design and communications services as described above @\$20,000.

Publication costs of \$5,000 are requested. \$4,800 will cover open access fees in Y3 (see for example, the *Journal of Public Economics* article publishing charge for open access). \$200 will cover submission fees in Y2. Total costs of design and publication is **\$36,000**.

## Symposium

The symposium will be held in Berkeley, CA. Previous experience suggests that most attendees, including speakers, have travel funds available through their agencies to attend in their professional capacities. However, we will offer scholarships and travel assistance, and actively solicit applications from potential attendees who can diversify the composition of the discussion geographically or by representing disadvantaged and underrepresented voices.

Symposium costs	Conference costs			
	Total event attendance	150		
	Item	Est'd cost per person		
	<i>continental breakfast</i>	\$8	\$1,200	
	<i>box lunch</i>	\$12	\$1,800	
	<i>coffee service</i>	\$5	\$750	
	<i>reception</i>	\$20	\$3,000	
	<i>materials (folders, printing etc)</i>	\$4	\$600	
	<i>University venue (free)</i>	\$0	\$0	
Scholarships and travel	Subtotal Conference costs		\$7,350	
	Number of scholarships	20		

Item	cost per person	subtotal
Lodging	\$150	\$3,000
Airfare	\$500	\$10,000
Per diem	\$62	\$1,240
<b>Scholarship subtotal</b>		<b>\$14,240</b>
<b>Total conference costs</b>		<b>\$21,590</b>

### **Video Production**

The video production budget will support the production of one or more video products designed to articulate key conceptual elements of EAR. The video effort will be informed by stakeholder engagement, and co-produced with key EAR practitioners. Our team has used similar approaches to help generate understanding and support for complex incentives for recharge in other projects, and we will build on this experience to target. Based on our prior experience with groundwater recharge video production, we will plan to produce between 3 and 5 videos, at a total cost of \$30,000, in Year 3 of the project.

### **Graduate Student Fee Remission**

The University of California provides full remission of tuition, fees, and graduate student health insurance to all graduate students who are employed on-campus 45% time or greater during the academic year. The rate for in-state remission is \$10,630 per semester in year 2 and \$11,161 per semester in year 3 assuming a 5% inflation rate.

### **Subawards**

Organization	Year 1	Year 2	Year 3	Total
UC Davis	\$24,563	\$28,304	\$29,392	\$82,259
UC Santa Cruz	\$83,677	\$82,985	\$88,250	\$254,912
UC Hastings	\$19,998	\$19,998	\$19,998	\$59,994
<b>Total</b>	<b>\$128,238</b>	<b>\$131,287</b>	<b>\$137,640</b>	<b>\$397,165</b>

#### **UC Davis**

Professors Helen Dahlke and Thomas Harter will lead, jointly with Professor Andrew Fisher (UCSC), research and synthesis on geophysical elements and technical methods for EAR.

#### **UC Santa Cruz**

Professor Andrew Fisher will lead, jointly with Professors Helen Dahlke and Thomas Harter, research and synthesis on geophysical elements and technical methods for EAR. Professor Fisher will also lead work on methods and considerations for managing water quality, in collaboration with others on the team.

## UC Hastings

Professor Dave Owen will lead research on legal, policy and institutional topics, in collaboration with Dr. Kiparsky, Dr. Green Nylen, Ms. Bruce, and others on the team.

### INDIRECT COSTS

Indirect Cost Rate %	Year 1	Year 2	Year 3	Total
60.5%	\$161,572	\$247,036	\$188,570	\$597,178

Indirect costs are based on University negotiated rates with the cognizant federal authority and are applied at a rate of 60.5%. Indirect costs are applied using the Modified Total Direct Cost (MTDC) formula, per rate agreement dated June 25, 2020. Modified total direct costs exclude equipment, capital expenditures, charges for patient care, student tuition remission, rental costs of off-site facilities, scholarships, and fellowships, participant support costs and the portion of each subgrant and subcontract in excess of \$25,000. For more information, please see: <http://www.spo.berkeley.edu/policy/fa.html>. The rates after July 1, 2022 are provisional and subject to change based upon our updated federally negotiated indirect cost rate agreement.

**Louise Wells Bedsworth**  
Center for Law, Energy, and the Environment, University of California, Berkeley  
Berkeley, California 94704

**Education**

**Doctor of Philosophy**, Energy and Resources, University of California, Berkeley  
**Master of Science**, Civil and Environmental Engineering, University of California, Berkeley  
**Bachelor of Science**, 1996, Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology

**Professional Experience**

June 2021 – present	Program Director, Land Use, Center for Law, Energy, and the Environment, Berkeley Law <i>Conducting policy-oriented research to support develop replicable tools to support sustainable land use; governance models that advance integrated land use; and implementation of community-engaged practices in research.</i>
July 2018 – April 2021	Executive Director, California Strategic Growth Council <i>Led core staff and associated partnerships in the development and execution of programs to support equitable, sustainable, resilient, and healthy community development in California.</i>
August 2013 – July 2018	Deputy Director, Governor's Office of Planning and Research <i>Led multidisciplinary staff to inform long-term planning and environmental policy in California.</i>
October 2011 – August 2013	Senior Researcher, Governor's Office of Planning and Research <i>Drafted comprehensive, long-term environmental goals and policy report and indicator set for State of California.</i>
August 2014 – August 2018	Adjunct Researcher, University of California, Davis <i>Principal Investigator for US EPA grant to integrate extreme events impacts into management decisions for air and water quality in California.</i>
July 2006 – August 2011	Research Fellow, Public Policy Institute of California <i>Conducted research on environmental policy issues relevant to California, including climate adaptation, local climate action, and transportation and land use.</i>
February 2003 – June 2011	Senior Vehicles Analyst, Union of Concerned Scientists <i>Led technical work to inform greenhouse gas emission standard development for passenger vehicles.</i>
July 2002 – February 2003	Visiting Fellow, Public Policy Institute of California <i>Analyzed air quality in the San Joaquin Valley.</i>

August 1996 – June 2002	Graduate Student Researcher, University of California, Berkeley <i>Examined roles of science and uncertainty in regulatory decision making.</i>
January – May 2002	Research Analyst, Redefining Progress <i>Supported development of ecological footprint calculator</i>

### Peer-Reviewed Publications

Baker, Z., J Ekstrom, K. Meagher, BL Preston, and **L. Bedsworth**. 2020. The Social Structure of Climate Research and Practitioner Engagement: Evidence from California. *Global Environmental Change* 63: <https://doi.org/10.1016/j.gloenvcha.2020.102074>.

Ekstrom, JA and **L Bedsworth**. 2018. Adapting air quality management for a changing climate: Survey of local districts in California. *Journal of the Air & Waste Management Association* 68(9): 931-944.

Baker, Z; J Ekstrom, and **L Bedsworth**. 2018. Climate information? Embedding climate futures within temporalities of California water management, *Environmental Sociology* 4:4, 419-433.

Ekstrom, JA; **L Bedsworth**; and A Fencl. 2017. Gauging climate preparedness to inform adaptation needs: local level adaptation in drinking water quality in CA, USA. *Climatic Change* 140: 467-481.

Franco, Guido, **Louise Bedsworth**, and Amber Pairis. 2014. California's Comprehensive Climate Change Program: The Pivotal Role of Research. *EM Bedsworth, Louise* and Ellen Hanak. 2012. Climate Policy at the Local Level: Insights from California. *Global Environmental Change* 23(3): 664-677.

**Bedsworth, Louise**. 2012. California's local health agencies and the state's climate adaptation strategy. *Climatic Change* 111(1): 119-133.

**Bedsworth, Louise**. Air Quality Planning in California's Changing Climate. *Climatic Change* 111(1): 101-118.

**Bedsworth, Louise** and Ellen Hanak. 2012. Guest Editorial: Preparing California for a Changing Climate. *Climatic Change* 111(1): 1-4.

**Bedsworth, Louise** and Ellen Hanak. 2010. Adaptation to Climate Change – A Review of Challenges and Tradeoffs in Six Sectors. *Journal of the American Planning Association* 76(4): 477-495.

**Bedsworth, Louise**. 2009. Climate Change and California's Local Health Officers – A Role for Scientists. *Bulletin of the American Meteorological Society*: doi: 10.1175/2008BAMS2745.1. [Online 18 December 2008]

**Bedsworth, Louise**. 2009. Preparing for Climate Change: A Perspective from Local Public Health Officers in California. *Environmental Health Perspectives* 117(4): 617-623.

**Bedsworth, Louise Wells**, Micah D. Lowenthal, and William E. Kastenberg. 2004. Uncertainty and Regulation: The Rhetoric of Risk in the California Low-Level Radioactive Waste Debate. *Science, Technology, and Human Values* 29: 406 - 427.

**Bedsworth, Louise Wells** and William E. Kastenberg. 2002. Science and Uncertainty in Environmental Regulation: Insights from the Evaluation of California's Smog Check Program. *Science and Public Policy* 29(1): 13-24.

## BIOGRAPHICAL SKETCH – MOLLY BRUCE

University of California, Berkeley, School of Law | 393 Simon Hall, Berkeley, CA 94720  
(704) 658-5306 | molly.bruce@berkeley.edu

### **EXPERIENCE**

---

#### **University of California, Berkeley School of Law : Center for Law, Energy & the Environment**, Berkeley, CA

*Wheeler Water Institute Water Policy Fellow*, September 2021 – Present

Support the proliferation of innovative groundwater recharge efforts.

#### **National Aeronautics and Space Administration : Jet Propulsion Laboratory (NASA JPL)**, Pasadena, CA

*Project Associate*, January 2021 – April 2021

Used satellite data to examine issues concerning climate adaptation—issues such as estuary loss—in order to develop predictive models.

#### **North Carolina Conservation Network**, Raleigh, NC

*Legal Extern*, August 2020 – May 2021

Supported the development of equitable & enduring clean energy policy in North Carolina.

#### **Duke University**, Durham, NC

*Graduate Teaching Assistant*, August 2020 – May 2021

Assisted graduate-level courses taught by (1) Prof. Steve Roady, Ocean & Coastal Law & Policy, (2) Dr. Pat Halpin & Prof. Jesse Clearly, Marine Geospatial Analysis, and (3) Prof. Jonathan Wiener and Prof. Kate Konschnik, Climate Change & the Law

#### **Marine Robotics & Remote Sensing Lab (MaRRS Lab)**, Beaufort, NC

*Researcher*, February 2020 – May 2021

Used innovative technologies including UASs, rovers, AUVs, and various software packages to address questions related to climate change.

#### **Nicholas Institute for Environmental Policy Solutions**, Durham, NC

*Researcher*, August 2019 – May 2021

Surveyed science & policy lit. concerning impacts to coastal ecosystems in specific states.

Developed a report for Pew Research Center.

#### **Duke University Center on Risk in Science and Society & Administrative Conference of the United States**, Durham NC

*Research Assistant for Dr. Lori Bennear & Prof. Jonathan Wiener*, March 2019 – May 2021

Examined how laws, regulations, and guidance documents influence adaptive approaches to administration of agency mandates. Conducted legal & policy research on *cy pres* resolutions & collective remedies to class actions—particularly within the environmental context.

#### **Surfrider Foundation**, San Clemente, CA

*Legal Department and Environmental Department Split Intern*, May 2019 – August 2019

Advocated for stewardship of marine resources before administrative lawmaking bodies.

Submitted public comments and gave public testimony.

#### **UNFCCC – International Institute for Sustainable Development**, Katowice, Poland

*COP24 Assistant*, November 2018 – December 2018

---

Augmented IISD's presence at COP24. Attended negotiations on IISD's behalf. Facilitated remote engagement with the climate negotiations.

**North Carolina Department of Justice – Environmental Division**, Raleigh, NC

*Coastal, Commissions, and Administrative Legal Intern*, May 2018 – August 2018

Drafted legal memoranda for litigation. Sought civil penalties for environmental contamination. Worked with state environmental agencies.

**Habitat for Humanity**, Durham, NC

*AmeriCorps Team Leader*, August 2016 – July 2017

Worked with the construction team. Led volunteer groups. Partnered with low-income families to fortify their homeownership success.

---

## EDUCATION

---

**Duke University School of Law**, Durham, NC

Juris Doctor, May 2021

*Honors:* Dean's Scholarship, Paul Hardin III Scholarship, & Burdman Fellowship  
NC Wildlife Federation Scholarship, Piedmont Silver Eagles Scholarship  
Public Interest Public Service Certificate

*Writing:* *Use of Drones for Conservation: Implications under the ESA & MMPA for the UAS research & hobbyist communities*

*Activities:* Duke University Board of Trustees, *Climate Change & Sustainability Task Force Advisor*  
Environmental Law Society, *President*  
Environmental Defense Fund, *Pro-Bono Research Project Leader*  
Oceana, *Pro-Bono Research Project Leader*

**Duke University Nicholas School of the Environment**, Durham, NC

Master of Environmental Management in Coastal Environmental Management, May 2021

*Honors:* Tim & Karen Hixon Wildlife Conservation Fellowship  
Geospatial Analysis Certificate

*Activities:* Ocean Policy Working Group, *Action Team Coordinator*

**University of North Carolina at Chapel Hill**, Chapel Hill, NC

Bachelor of Arts in Geography/GIS and Global Studies, *Magna Cumlaude*, May 2016

*Thesis:* *The Airway Less Traveled: The Gendered Experiences of Eight Female Pilots*

*Honors:* Phi Beta Kappa & Honors Laureate with Distinction  
Buckley Public Service Scholar  
J. Douglas Eyre Award for Outstanding Leadership

# ELLEN M. BRUNO

ebruno@berkeley.edu ◇ ellen-bruno.com

## EDUCATION

---

### University of California, Davis

Ph.D. in Agricultural and Resource Economics	2018
M.S. in Agricultural and Resource Economics	2016

### University of California, San Diego

B.S. in Management Science, <i>summa cum laude</i>	2013
Minors in Math, Environmental Science	

## APPOINTMENTS

---

07/2018 - present	Assistant Specialist in Cooperative Extension Department of Agricultural and Resource Economics University of California, Berkeley
-------------------	--

## SELECTED RESEARCH PUBLICATIONS

---

Ellen M. Bruno and Katrina Jessoe. (2021) "Using Price Elasticities of Water Demand to Inform Policy." *Annual Review of Resource Economics* 13.9: 1-15.

Ellen M. Bruno and Katrina Jessoe. (2021) "Missing Markets: Evidence on Agricultural Water Demand from Volumetric Pricing." *Journal of Public Economics* 196: 104374.

Bruno, Ellen M. and Richard J. Sexton. (2020) "The Gains from Agricultural Groundwater Trade and the Potential for Market Power: Theory and Application." *American Journal of Agricultural Economics* 102.3: 884-910.

DeVincentis, Alyssa J., Sam Sandoval Solis, Ellen M. Bruno, Amber Leavitt, Anna Gomes, Sloane Rice, and Daniele Zaccaria. (2020) "Using Cost-Benefit Analysis to Understand Adoption of Winter Cover Cropping in California's Specialty Crop Systems." *Journal of Environmental Management* 261: 110025.

Saitone, Tina L. and Ellen M. Bruno. (2020) "Cost Effectiveness of Livestock Guardian Dogs for Predator Control." *Wildlife Society Bulletin* 44.1: 101-109.

## SELECTED EXTENSION PUBLICATIONS

---

Bruno, Ellen M. (2021) "Identifying Policies to Mitigate the Costs of Drought." *ARE Update* 25.1: 13 - 15.

Ayres, Andrew, Ellen Hanak, Brian Gray, Gokce Sencan, Ellen Bruno, Alvar Escriva-Bou, and Greg Gartrell. (2021). "Improving California's Water Market: How Water Trading and Banking Can Support Groundwater Management." *Public Policy Institute of California*. Technical Report.

Bruno, Ellen M. and Heidi Schweizer. (2021) "Why Wall Street Investors' Trading California Water Futures is Nothing to Fear- and Unlikely to Work Anyway." *The Conversation*.

Wardle, Arthur R., Paige Griggs, and Ellen M. Bruno. (2021) "A Progress Report on California's Sustainable Groundwater Management Act." *ARE Update* 24.3: 1-4.

Bruno, Ellen M., Alyssa DeVincentis, Sam Sandoval Solis, and Daniele Zaccaria. (2020) "Assessing the Costs and Benefits of Winter Cover Cropping in California." *ARE Update* 23.6: 9-11.

Bruno, Ellen M., Andrew Ayres, and Emmanuel Asinas. (2019) "Managing Flood Water for Aquifer Recharge: Economic Considerations for Policy." *Global Water Forum*.

Bruno, Ellen M. and Tina Saitone. (2019) "Livestock Guardian Dogs: Do the Benefits Outweigh the Costs for Sheep Producers?" *ARE Update* 22.6: 9-11.

Bruno, Ellen M. and Katrina Jessoe. (2018) "Climate Change and California's Water Supply: How Can We Adapt?" *ARE Update* 22.1: 1-3.

Bruno, Ellen M. (2018) "The Economic Impacts of Agricultural Groundwater Markets." *ARE Update* 21.6: 9-11.

## AWARDS

---

- 2020 Award for Most Downloaded Article in the 2019-2020 Issue of *ARE Update*
- 2019 Award for Most Downloaded Article in the 2018-2019 Issue of *ARE Update*
- 2019 Outstanding Doctoral Dissertation Award, *Agricultural & Applied Economics Association*
- 2019 Gordon A. King Award for Best Dissertation, ARE Dept, UC Davis
- 2017 Award for Most Downloaded Article in the 2016-2017 Issue of *ARE Update*
- 2017 Outstanding Graduate Paper Award, *Western Agricultural Economics Association*
- 2013 Joel Dean Award for Excellence in Management Science, UC San Diego

## RECENT PRESENTATIONS

---

**2021:** The National Academy of Sciences, Water Science and Technology Board Meeting; Property and Environment Research Center (PERC) Workshop on Water Markets; Pennsylvania State University; SWELL (Seminar in Water Economics onLLine); University of Arizona; Groundwater Resources Association Future of Water Conference

**2020:** AGU Conference; UC Davis; Cal Poly College of Agriculture, Food, and Environmental Sciences; AAEA Pre-conference Workshop on Specialty Crop Challenges; UC ANR Pistachio Workgroup Meeting; Groundwater Resources Association 3rd Annual GSA Summit; UC ANR Silver Solutions Seminar; NGO Groundwater Collaborative Workshop; UC ANR Water Program Team Meeting, Davis, CA; Giannini Foundation Big Ag Data Conference, Davis, CA; AERE @ ASSA, San Diego, CA.

## PROFESSIONAL ACTIVITIES

---

- 2021 Member, Ad Hoc Advisory Panel for SWEEP, CA Department of Food & Agriculture
- 2020 - present Member, Public Policy Institute of California Water Policy Center Research Network
- 2020 - present Co-chair, UC ANR Water Program Team
- 2020 - present Member, Union of Concerned Scientists Groundwater Technical Assistance Network
- 2019 - 2021 UC Berkeley Representative, UC ANR Academic Assembly Council
- 2019 - 2021 Abstract Reviewer, AERE Summer Conference
- 2019 - present Panel Member, UC ANR Strategic Initiative: Water Quality, Quantity, and Security
- 2019 - 2020 Selected Paper Topic Leader, AAEA Annual Meeting
- 2018 - present Co-editor, *ARE Update*
- 2018 - 2019 Member, Economic Advisory Subcommittee for Flood-MAR Program, California Department of Water Resources

---

**Biographical Sketch****Helen E. Dahlke**

University of California, Davis  
 Land, Air and Water Resources  
 One Shields Avenue  
 Davis, CA 95616

Phone: +1 (530) 302-5358  
 Email: [hdahlke@ucdavis.edu](mailto:hdahlke@ucdavis.edu)  
 Web: <http://dahlke.ucdavis.edu>  
<https://orcid.org/0000-0001-8757-6982>

***Education and Training***

<u>College/University</u>	<u>Major</u>	<u>Degree, Year</u>
Friedrich-Schiller University of Jena, Germany	Physical Geography	MSc 2004
Cornell University, Biological and Environmental Engineering	Environmental Engineering	PhD 2011

***Research and Professional Experience***

<u>Associate Professor in Integrated Hydrologic Sciences</u> Land, Air and Water Resources, University of California, Davis	04/ 2017 – present
Assistant Professor in Integrated Hydrologic Sciences Land, Air and Water Resources, University of California, Davis	04/ 2013 – 03/207
Postdoctoral Research Associate, Stockholm University, Sweden	10/2010 – 04/2013

***Synergistic Activities******Grants***

**PI** United States Department of Agriculture award (2020-2024) *Synergistic Managed Aquifer Recharge Strategies to Sustain Irrigated Agriculture* (\$800,000);

**Co-PI** United States Department of Agriculture award (2021-2023) *Quantifying the environmental effects of implementing managed agricultural aquifer recharge in agricultural production systems*. Scott Bradford (PI) (\$600,000);

**PI** Gordon and Betty Moore Foundation (2018-2022) *Developing science-based approaches to managed agricultural groundwater re-charge in California's Central Valley*. (\$1,650,000);

**PI** National Science Foundation Award (2017-2021) CNH-L: *The dynamics of rural poverty, land use, and water in California's changing Central Valley* (\$1,599,743) focusing on estimating climate change impacts on the surface and groundwater supply of the Tulare Lake Basin and recommendations for climate adaptation for disadvantaged communities;

**PI** California Department of Pesticide Regulation Award (2018-2021) *A Field Study to Evaluate the Impacts of On-farm Recharge on the Leaching Behavior of Agricultural Pesticides*. (\$299,559);

**PI** USDA Economic Research Service Award (2018-2021) *Regional Aquifer Management: Hydrology of Managed Aquifer Recharge in the Central Valley Aquifer and Mississippi Embayment*. (\$299,947);

**Co-PI** Binational Agricultural Research and Development Award (2018-2021) *Increasing water availability through agricultural groundwater recharge*. (\$310,000).

***Scientific and Public Outreach***

- Congressional science briefing titled ‘Water security in the West: A science briefing on water for people and nature’ in Washington D.C to inform members of congress, DOI, USDA, Office of Management and Budget, Congressional Research Service, U.S. Global

## Biographical Sketch

---

Change Research Program on water, climate change and agricultural groundwater banking in California (25-26 Oct. 2016)

- I have given over 100 presentations on agricultural managed aquifer recharge in the past 5 years

### *Honors and Awards*

USDA ThinkWater Fellow 2017

LEAD21 Program Fellow of 2020-2021

### ***Products most closely related to the proposed project***

- Murphy, N.P., H. Waterhouse, and **H.E. Dahlke**. Influence of Agricultural Managed Aquifer Recharge on nitrate transport – the role of soil type and flooding frequency. *Vadose Zone Journal*, <https://doi.org/10.1002/vzj2.20150>.
- Ganot, Y. and **H.E. Dahlke**. A model for estimating Ag-MAR flooding duration based on crop tolerance, root depth, and soil texture data. *Agricultural Water Management*, <https://doi.org/10.1016/j.agwat.2021.107031>.
- Ganot, Y. and **Dahlke, H.E.**, 2021. Natural and forced soil aeration during agricultural managed aquifer recharge. *Vadose Zone Journal*, p.e20128, <https://doi.org/10.1002/vzj2.20128>.
- Waterhouse, H., Arora, B., Spycher, N.F., Nico, P.S., Ulrich, C., **Dahlke, H.E.** and Horwath, W.R., 2021. Influence of Agricultural Managed Aquifer Recharge (AgMAR) and Stratigraphic Heterogeneities on Nitrate Reduction in the Deep Subsurface. *Water Resources Research*, p.e2020WR029148, <https://doi.org/10.1029/2020WR029148>.
- Marwaha, N., Kourakos, G., Levintal, E., and **Dahlke, H.E.** 2021. Identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities. *Water Resources Research*, <https://doi.org/10.1029/2020WR028811>.
- Waterhouse, H., Bachand, S., Bachand, P.A.M., Mountjoy, D., Choperena, J., **Dahlke, H.E.**, Horwath, W.R. 2020. Agricultural managed aquifer recharge — water quality factors to consider. *California Agriculture* 74(3):144-154. <https://doi.org/10.3733/ca.2020a0020>.
- Pauloo, R., Escriva-Bou, A., **Dahlke, H.**, Fencl, A., Guillou, H. and Fogg, G., 2020. Domestic well vulnerability to drought duration and unsustainable groundwater management in California's Central Valley. *Environmental Research Letters*. <https://doi.org/10.1088/1748-9326/ab6f10>.
- Kourakos, G., **Dahlke, H.E.**, Harter, T. 2019. Increasing Groundwater Availability and Baseflow through Agricultural Managed Aquifer Recharge in an Irrigated Basin. *Water Resources Research*, <https://doi.org/10.1029/2018WR024019>.
- Ghasemizade, M., Asante, K., Peterson, C., Kocis, T.N., **Dahlke, H.E.**, Harter, T. 2019. An integrated approach toward groundwater banking in the southern Central Valley, California. *Water Resources Research*, <https://doi.org/10.1029/2018WR024069>.
- **Dahlke, H.E.**, LaHue, G.T., Mautner, M.R.L., Murphy, N.P., Patterson, N.K., Waterhouse, H., Yang, F. and Foglia, L. 2018. Managed Aquifer Recharge as a tool to enhance sustainable groundwater management in California: examples from field and modeling studies. In Friesen, J., Sinobas, L.R. (eds.), *Advances in Chemical Pollution, Environmental Management and Protection: Advanced Tools for Integrated Water Resources Management Volume 3*, Elsevier Publishing, 66 pp. <https://doi.org/10.1016/bs.apmp.2018.07.003>.
- Kocis, T.N. and **H.E. Dahlke**. 2017. Availability of high-magnitude streamflow for groundwater banking in the Central Valley, California. *Environmental Research Letters*, 12: 084009.

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.  
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

---

NAME: Fisher, Andrew

---

eRA COMMONS USER NAME (credential, e.g., agency login):

---

POSITION TITLE: Distinguished Professor

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
Stanford University, Stanford, CA	BS	06/1984	Geology
University of Miami, RSMAS, Miami, FL	PHD	05/1989	Marine Geology and Geophysics

### A. Personal Statement

Fisher is the UCSC Director for UC Water, co-PI for the Center for Dark Energy Biosphere Investigations, and founder of The Recharge Initiative ([www.rechargeinitiative.org](http://www.rechargeinitiative.org)), a focused effort to protect, enhance, and improve the availability and reliability of groundwater resources. Fisher has authored or co-authored >200 articles, book chapters, reports, and other documents, and supervised 24 graduate students and >50 undergraduate student researchers. Fisher teaches classes in geology, hydrology, groundwater, and groundwater modeling, and conducts research on: managed recharge, geothermics, marine hydrothermal circulation, surface water – groundwater interactions, coupled flows (fluid-heat-solutes), water quality, and development of new hydrologic tools and techniques. He has served on numerous technical advisory committees for agencies, municipalities, and NGOs. Here are some recent publications relevant to this proposal:

1. Pensky J, Fisher AT, Gorski G, Schrad N, Beganskas S, Saltikov C. Enhanced cycling of nitrogen and metals during rapid infiltration: implications for managed recharge. *Science of the Total Environment*. Forthcoming; in review.
2. Gorski G, Dailey H, Fisher AT, Schrad N, Saltikov C. Denitrification during infiltration for managed aquifer recharge: Infiltration rate controls and microbial response. *Sci Total Environ*. 2020 Jul 20;727:138642. PubMed PMID: 32334223.
3. Beganskas S, Young KS, Fisher AT, Harmon R, Lozano S. Runoff Modeling of a Coastal Basin to Assess Variations in Response to Shifting Climate and Land Use: Implications for Managed Recharge. *Water Resource Management*. 2019 February 08; 33:1683-1698. Available from: <https://link.springer.com/article/10.1007%2Fs11269-019-2197-4> DOI: 10.1007/s11269-019-2197-4
4. Kiparsky M, Milman A, Owen D, Fisher AT. The Importance of Institutional Design for Distributed Local-Level Governance of Groundwater: The Case of California's Sustainable Groundwater Management Act. *Water*. 2017 September 30; 9(10):755-. Available from: <http://www.mdpi.com/2073-4441/9/10/755> DOI: 10.3390/w9100755

### B. Positions, Scientific Appointments and Honors

#### Positions and Scientific Appointments

2019 - Distinguished Professor, University of California, Santa Cruz, Earth and Planetary Sciences Department, affiliated with: Ocean Sciences, Environmental Studies, Microbiology and Environmental Toxicology, Santa Cruz, CA

2003 - 2019 Professor, University of California, Santa Cruz, Earth and Planetary Sciences Department, Santa Cruz, CA

1999 - 2003 Associate Professor, University of California, Santa Cruz, Department of Earth Sciences, Santa Cruz, CA

1995 - 1999 Assistant Professor, University of California, Santa Cruz, Department of Earth Sciences, Santa Cruz, CA

1993 - 1995 Associate Scientist and Graduate Faculty, Indiana University, Department of Geological Sciences and Indiana Geological Survey, Bloomington, IN

1993 - 1993 Visiting Assistant Professor, Texas A & M University, Department of Geophysics, College Station, TX

1989 - 1993 Adjunct Assistant Professor, Texas A & M University, Department of Geophysics, College Station, TX

1989 - 1993 Staff Scientist, Texas A & M University, Ocean Drilling Program, College Station, TX

1988 - 1988 Exploration Geologist, Shell Western Exploration & Production, Inc., Houston, TX

## **Honors**

2020 - 2022 Distinguished Lecturer, Sigma Xi

2016 - 2017 Distinguished Lecturer, International Ocean Discovery Program

2003 - 2004 Distinguished Lecturer, National Science Foundation - RIDGE2000

1996 - 1997 Distinguished Lecturer, JOI/United States Science Support Program

2019 Fellow, American Association for the Advancement of Science

2018 Fellow, American Geophysical Union

2017 Excellence in Teaching Award, University of California, Santa Cruz

2016 O. E. Meinzer Award in Hydrogeology, Geological Society of America

2016 Watershed Hero Award, Blue Circle, Santa Cruz County

2012 Excellence in Teaching Award, University of California, Santa Cruz

2011 Bennett Distinguished Lecturer, University of Leicester, UK

2008 Distinguished Service Award, College 8, University of California, Santa Cruz

2006 Fellow, Geological Society of America

## **C. Contribution to Science**

### 1. Additional, selected publications related to proposed work:

- a. Miller K, Fisher AT, Kiparsky M. Incentivizing Groundwater Recharge in the Pajaro Valley Through Recharge Net Metering (ReNeM). *Case Studies in the Environment*. 2021 April 21; 5(1). Available from: <https://online.ucpress.edu/cse/article/5/1/1222393/116573/Incentivizing-Groundwater-Recharge-in-the-Pajaro?searchresult=1>
- b. Gorski G, Fisher AT, Beganskas S, Weir WB, Redford K, Schmidt C, Saltikov C. Field and Laboratory Studies Linking Hydrologic, Geochemical, and Microbiological Processes and Enhanced Denitrification during Infiltration for Managed Recharge. *Environ Sci Technol*. 2019 Aug 20;53(16):9491-9501. PubMed PMID: 31352778.
- c. Beganskas S, Gorski G, Weathers T, Fisher A, Schmidt C, Saltikov C, Redford K, Stoneburner B, Harmon R, Weir W. A horizontal permeable reactive barrier stimulates nitrate removal and shifts microbial ecology during rapid infiltration for managed recharge. *Water Research*. 2018 November; 144:274-284. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0043135418305827> DOI: 10.1016/j.watres.2018.07.039
- d. Beganskas S, Fisher AT. Coupling distributed stormwater collection and managed aquifer recharge: Field application and implications. *J Environ Manage*. 2017 Sep 15;200:366-379. PubMed PMID: 28599220.

**Biographical Sketch — Nell Green Nylen**

University of California, Berkeley, School of Law • 393 Simon Hall, Berkeley, CA 94720  
 ngreennylen@berkeley.edu

**Education**


---

Stanford University	Geological and Environmental Sciences	B.S.	1996
Stanford University	Geological and Environmental Sciences	Ph.D.	2005
University of California, Berkeley	Law	J.D.	2012

**Work Experience**


---

2016-present	Senior Research Fellow, Wheeler Water Institute, Center for Law, Energy & the Environment, University of California, Berkeley, School of Law, Berkeley, CA
2013–2016	Research Fellow, Wheeler Water Institute, Center for Law, Energy & the Environment, University of California, Berkeley, School of Law, Berkeley, CA
2012–2013	Law Clerk to Justice Gregory J. Hobbs, Jr., Colorado Supreme Court, Denver, CO
2011	Teaching Assistant (Part-time), University of California, Berkeley, School of Law, Berkeley, CA
2011	Legal Intern, California Attorney General's Office, Oakland, CA
2010	Legal Intern, Center for Biological Diversity, San Francisco, CA
2009	Research and Curatorial Assistant, California Academy of Sciences, San Francisco, CA
2006–2008	Museum Assistant and GIS Specialist (Part-time), Yale Peabody Museum of Natural History, New Haven, CT
2006–2008	Assistant to Professor Michael Donoghue (Part-time), Yale University, New Haven, CT
1998–2002	Teaching Assistant (Part-time), Stanford University, Stanford, CA
1997–1998	GIS, CAD, and Graphics Specialist, Stanford University, Stanford, CA
1997	GIS and Graphics Intern, Stanford University, Stanford, CA
1996–1997	Geologist, United States Geological Survey, Menlo Park, CA
1995–1996	Teaching Assistant, Stanford University, Stanford, CA

**Selected Publications**


---

Lidia Cano Pecharroman, Christopher Williams, Nell Green Nylen, and Michael Kiparsky. (2021) “How Can We Govern Large-Scale Green Infrastructure for Multiple Water Security Benefits?” *Blue Green Systems* 3(1): 62–80.

Nell Green Nylen. (2021) “Surface Water Quality Regulation as a Driver for Groundwater Recharge: The Case of Virginia’s Sustainable Water Initiative for Tomorrow.” *Case Studies in the Environment* 5(1): 1124592.

Kate Fritz and Nell Green Nylen. (2020) “When Does a Groundwater Recharge Project NOT Need a Water Right?” *Legal Planet*, Aug. 3, 2020.

Kate Fritz and Nell Green Nylen. (2020) “Water Right Permitting Options for Groundwater Recharge: Avoiding Unintended Consequences.” [Legal Planet](#), July 27, 2020.

Dave Owen, Alida Cantor, Nell Green Nylen, Thomas Harter, and Michael Kiparsky. (2019) “California Groundwater Management, Science-Policy Interfaces, and the Legacies of Artificial Legal Distinctions.” [Environmental Research Letters](#) 14(4): 045016.

Kathleen Miller, Nell Green Nylen, Holly Doremus, Dave Owen, and Andrew Fisher. (2018) [Issue Brief: When Is Groundwater Recharge a Beneficial Use of Surface Water in California?](#). Center for Law, Energy & the Environment, University of California. 8 pp.

Nell Green Nylen, Michael Kiparsky, Dave Owen, Holly Doremus, and Michael Hanemann. (2018) [Addressing Institutional Vulnerabilities in California’s Drought Water Allocation, Part 1: Water Rights Administration and Oversight During Major Statewide Droughts, 1976–2016](#), California’s Fourth Climate Change Assessment, California Natural Resources Agency, Publication number: CCCA4-CNRA-2018-009. 172 pp.

Alida Cantor, Dave Owen, Thomas Harter, Nell Green Nylen, and Michael Kiparsky. (2018) [Navigating Groundwater-Surface Water Interactions Under the Sustainable Groundwater Management Act](#). Center for Law, Energy & the Environment, University of California, Berkeley. 50 pp.

Nell Green Nylen, Michael Kiparsky, Kelly Archer, and Kurt Schnier. (2017) [Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act](#). Center for Law, Energy & the Environment, University of California, Berkeley. 90 pp.

Nell Green Nylen and Michael Kiparsky. (2015) [Accelerating Cost-Effective Green Stormwater Infrastructure: Learning from Local Implementation](#). Center for Law, Energy & the Environment, University of California, Berkeley. 47 pp.

### **Synergistic Activities and Associations**

- Member, Executive Committee of Environmental Law Section of the California Lawyers Association, 2020–present
- Board Member, California Water Law Symposium Board of Directors, 2019–present (Secretary, 2021–present)
- Member, County Drought Advisory Group, convened by California Department of Water Resources to aid AB 1668 implementation, 2018–2020
- More than 20 invited presentations from 2014–2021
- Worked with 16 undergraduate or graduate student research assistants from 2014–2021

### **Bar Admission**

California (inactive)

## Thomas Harter, Ph.D., Nora S. Gustavsson Endowed Professor in Water Resources

Department of Land, Air, and Water Resources, University of California, Davis, CA 95616  
ph/530-400-1784; [tharter@ucdavis.edu](mailto:tharter@ucdavis.edu); <http://groundwater.ucdavis.edu>;

### HISTORY OF EMPLOYMENT

2015-present	Professor and Professor of Cooperative Extension
2005-2015	Professor of Cooperative Extension
1999-2005	Associate Professor of Cooperative Extension (equivalent to Assoc. Professor)
1995-1999	Assistant Professor of Cooperative Extension (equivalent to Asst. Professor)
1994-1995	Postdoctoral Fellow, Dept. Hydrology and Water Resour., Univ. of Arizona
1987-1994	Graduate Research Assistant, Universität Freiburg, Germany and Univ. of Arizona

### DEGREES

University of Arizona	Hydrology	Ph.D., 1994
Universität Freiburg, Germany	Hydrology	Diplom (M.S.), 1989
Universität Freiburg, Germany	Physical Geography/Hydrology	Vordiplom (B.S.), 1985

### RESEARCH EXPERIENCE

**Summary:** Pioneering research into understanding of subsurface flow and transport processes, process dynamics, and quantifying external stressors at the highly heterogeneous, multi-scale, multi-dimensional, and multi-disciplinary interface between agriculture and groundwater. My work has not only provided significant and broad new scientific insights, but also important technical tools and information used by scientists, consultants, a broad diversity of stakeholders, and by policy and decision makers in efforts for more efficient and sustainable management of groundwater resources in agricultural regions.

**Agricultural Pollution Source Characterization and Pollutant Fate/Transport in the Deep Vadose Zone;**

- Quantification and assessment of pollutant sources and alternative management practices across large agricultural landscapes (nitrate, pathogens, pharmaceutical);
- Development of new methods to assess and understand long-term dynamics of agricultural pollutant fate and transport in heterogeneous, deep alluvial vadose zones; including field characterization, laboratory measurements, and development of advanced stochastic computer modeling approaches.

**Legacy and Emerging Agricultural Nonpoint Source Contamination of Shared Groundwater Resources:**

**Pollutant Sources, Fate, and Transport, Remedial Actions, and Management Tools;**

- Development of stochastic approaches for the assessment of groundwater contamination;
- Mathematical/computational methods development for fate and transport modeling, upscaling across bench-, plot-, field-, farm-, to regional scale.
- Development and application of highly efficient, high resolution basin-scale nonpoint source transport modeling software;
- Development of monitoring network designs and best management practices;
- Environmental fate and transport of salts, nitrate, pathogens (Cryptosporidium, E. Coli H7 O157, Salmonella, Campylobacter), antibiotics and other pharmaceuticals, steroid hormones;
- Groundwater forensics related to identifying a diversity of agricultural and non-agricultural nonpoint (diffuse) pollution sources;

**Groundwater Resources Modeling, Assessment, and Management in Irrigated Agriculture-dominated Basins:**

Development of integrated, field research-based approaches to basin groundwater and surface water models, e.g., for the development of conjunctive use management strategies in semi-arid irrigated agricultural regions and for sustainable groundwater management that is aimed at not only preventing overdraft, land subsidence, and seawater intrusion, but also protects groundwater-dependent ecosystems including baseflow in streams with sensitive habitats

**HONORS & MEMBERSHIPS**

2021-current	Nora S. Gustavsson Endowed Professor, Water Resources, UC Davis
2007-2020	Robert M. Hagan Endowed Chair, Water Management and Policy, UC Davis
2008	Western Extension Directors' Award of Excellence
2007	Kevin J. Neese Award, Groundwater Resources Association
1991	Harshbarger Fellow, University of Arizona
1985	Fulbright Fellow, University of Arizona

Member- Soil Science Society of America, Groundwater Resources Association, International Association of Hydrology, and American Geophysical Union

**SERVICE TO THE COMMUNITY - SELECTED ACTIVITIES**

Scientific advisor in numerous national, state, and regional capacities (legislative committees, technical advisory committees, scientific advisor, expert reviewer, convener/organizer of multiple conferences) focused on the development and implementation of policies and regulations at the groundwater-agriculture nexus, including California's 2014 Sustainable Groundwater Management Act and its regulatory framework and guidance, on the implementation and assessment of over 150 Groundwater Sustainability Plans, and the nonpoint source (nitrate and salinity) regulatory development of California's Water Quality Control Act (Dairy Order, Irrigated Lands Regulatory Program, Salinity and Nutrient Management Plans) and similar planning and assessment efforts nationally and internationally. Annually providing nearly 100 presentations, workshops, invited lectures, technical consultations to decision-makers, in addition to extensive state and national committee service guiding stakeholders, NGOs, and state and federal policy makers.

1998-current	Member & Chair (1998-2000), Vadose Zone Technical Committee
2017-present	Associate Director, UC Davis Center for Watershed Sciences
2016-present	Chair, Hydrologic Sciences Graduate Group, UC Davis
2014-present	Board of Directors, Water Education Foundation
2008-2019	Board of Directors, Groundwater Resources Association

2016 and 2010 Lead organizer and chair of the International Conference "[Toward Sustainable Groundwater in Agriculture: Linking Science and Policy](#)", San Francisco, California. Brought together scientists, water managers, and agricultural leaders from around the world to present and discuss research and challenges at the groundwater-agriculture nexus.

2012 - Lead author and senior project director, [Nitrate in Drinking Water Study for 2012 Report to the California Legislature](#). Major scientific-technical study and policy analysis for the California legislature, including eight peer-reviewed technical reports (1,300+ pages), a main report, 12 peer-reviewed scientific articles, invited presentations and briefings to state, national, and international audiences, stakeholder groups, and state leadership.

1995-current Teacher of undergraduate and graduate courses at UC Davis on groundwater hydrology, groundwater modeling, and the global groundwater-agriculture nexus. Delivers two to four short courses annually through GRA, WEF, University of Freiburg, and others, with 20-250 participants in each.

2004-2010	Associate Editor, Water Resources Research
2014-present	Associate Editor, Journal of Environmental Quality
2004-2018	Associate Editor, Vadose Zone Journal
2011	Guest Editor, WRR special issue " <a href="#">Toward Sustain. Groundwater in Agriculture</a> "
2020-2021	Guest Editor, Vadose Zone Journal, special issue on transboundary soil hydrology

## MICHAEL KIPARSKY

### EDUCATION

2005-2010 **Ph.D.**, *Energy and Resources Group, University of California, Berkeley*  
 2002-2004 **MS**, *Energy and Resources Group, University of California, Berkeley*  
 1990-1995 **AB**, *Department of Ecology & Evolutionary Biology, Brown University*

### SELECTED HONORS AND AWARDS

2018 **Invited contributor**, “Tenth Biennial Rosenberg International Forum on Water Policy - Sustainable Groundwater Management: The Path Forward,” San Jose, CA, October 2018.  
 2017 **Winner** (with Richard Roos-Collins), Imagine H<sub>2</sub>O California Water Policy Challenge, April 2017  
 2016 **Invited participant**, “California’s Water Future: An Advanced Communication Workshop.” COMPASS, Santa Barbara, May 2016  
 2016 **Highlighted** as one of “Nine Experts to Watch on California Water Policy” by *Water Deeply*, July 7, 2016. <https://www.newsdeeply.com/water/articles/2016/07/07/nine-experts-to-watch-on-california-water-policy>  
 2011 **NSF** CHANS Fellow, International Network of Research on Coupled Human and Natural Systems, 2011 AAAS Annual Meeting (\$1000)  
 2010 **NSF** American Meteorological Society Policy Colloquium Scholarship (~\$8,000 for tuition and travel)  
 2009 **Udall** Environmental Public Policy & Conflict Resolution Ph.D. Fellowship (\$24,000; one of two awarded nationally)  
 2008 **NSF** Doctoral Dissertation Improvement Grant (with Michael Hanemann). Funded jointly by Geography and Regional Science Program and Decision, Risk and Management Science Program (BCS-0826103; \$11,975)  
 2008 **CALFED** Science Fellowship (\$98,750)  
 2008 **Association of California Water Agencies** Steven K. Hall ACWA Water Law & Policy Scholarship (\$7,000; one awarded)  
 2003 **NSF** Graduate Research Fellowship (\$122,500)

### ACADEMIC APPOINTMENTS

2015-present **Director**, *Wheeler Water Institute*  
 2012-15 **Associate Director**, *Wheeler Water Institute*  
*Center for Law, Energy and the Environment, UC Berkeley School of Law*, Berkeley, CA  
 2015-19 **Co-Director**, **UC Water Security and Sustainability Research Initiative (UC Water)**  
[www.ucwater.org](http://www.ucwater.org)  
 2012-13 **Research Scientist**  
*Berkeley Water Center, UC Berkeley*, Berkeley, CA  
 2010-2011 **Research Assistant Professor**  
*Department of Geography, University of Idaho*, Moscow, ID

### RELEVANT PROFESSIONAL EXPERIENCE

2007-2011 **Senior Resources Planner** *Tully & Young, Inc.*, Sacramento, CA  
 2003-2005 **Science Policy Analyst** *CALFED Science Program*, Berkeley and Sacramento, CA  
 2002-2004 **Research Assistant and Research Affiliate** *Pacific Institute*, Oakland, CA

### OTHER RELEVANT ACTIVITIES

- Extensive experience with stakeholder engagement, including convening, moderating, and facilitating over a dozen major forums resulting in published synthesis (outputs) and impacts on decision making (outcomes).
- Regular invited testimony and outreach to state agencies.
- Consistent mentions, quotes and interviews in state, national, and international media outlets.

## SELECTED RELEVANT FUNDED PROJECTS

2021	**Santa Clara Valley Water District, "Water Resource Innovation Partnership (WRIP)," (\$249,863)
2021	**Gordon and Betty Moore Foundation, "Recharge Net Metering (ReNeM) to secure water resources, enhance aquatic systems, sustain landscapes, and empower local institutions," (\$980,196)
2019	†The Water Foundation, "Making Recharge Net Metering work: Implementation, validation, and engagement to enable broader adoption of an innovative incentive system for recharge," (with UCSC and Resource Conservation District of Santa Cruz, \$100,000)
2018	†Nestle Waters North America, "Incentives for Groundwater Recharge," (\$186,000)
2017	†USDA Agriculture and Food Research Initiative (AFRI), "Recharge Net Metering: Application and Evaluation of a Novel Approach to Achieving Sustainable Groundwater Supply and Quality," (\$463,338)
2016	†The Nature Conservancy, "Governance and Financing for Multi-Benefit Natural Infrastructure." (\$50,000)
2015	†UC Office of the President Multicampus Research Programs and Initiatives, "UC Water Security and Sustainability Research Initiative" (\$3,529,750)
2012	†NSF IGERT "Adaptation to Change in Water Resources: Science to Inform Decision-making Across Disciplines, Cultures and Scales" (University of Idaho, DGE 1249400; \$3,099,997)

## SELECTED RELATED JOURNAL ARTICLES

- Lidia Cano Pecharroman, Christopher Williams, Nell Green Nylen, and **Michael Kiparsky**. 2021. How can we govern large-scale green infrastructure for multiple water security benefits? *Blue-Green Systems* 3(1):62.
- Kathleen Miller, Anita Milman, and **Michael Kiparsky**. 2021. Introduction to the Special Collection: Institutional Dimensions of Groundwater Recharge. *Case Studies in the Environment* 5(1):1245648.
- Dave Owen, Alida Cantor, Nell Green Nylen, Thomas Harter and **Michael Kiparsky**. 2019. "California groundwater management, science-policy interfaces, and the legacies of artificial legal distinctions." *Environmental Research Letters* 14(4): 045016
- **Michael Kiparsky**, Anita Milman, Dave Owen, and Andrew T. Fisher. 2017. "The Importance of Institutional Design for Distributed Local Level Governance of Groundwater." *Water*, 9(10):755.
- **Michael Kiparsky**. 2016. "Unanswered questions for implementation of the Sustainable Groundwater Management Act." *California Agriculture* 70(4): 165-168.

## SELECTED RELATED POLICY WHITEPAPERS AND OP-EDS

- **Kiparsky, M**, AT Fisher. WM Hanemann, J Bowie, R Kantor, C Coburn, and B Lockwood. 2018. Recharge Net Metering to Enhance Groundwater Sustainability. Center for Law, Energy & the Environment, UC Berkeley School of Law, Berkeley, CA. 4 pp. doi.org/10.15779/J2792D
- Cantor, A, D Owen, T Harter, N Green Nylen, and **M Kiparsky**. 2018. Navigating Groundwater-Surface Water Interactions under the Sustainable Groundwater Management Act. Center for Law, Energy & the Environment, UC Berkeley School of Law, Berkeley, CA. 50 pp. doi.org/10.15779/J23P87
- Nell Green Nylen, **Michael Kiparsky**, Kelly Archer, and Kurt Schnier. 2017. Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act. Center for Law, Energy & the Environment, University of California at Berkeley. Berkeley, CA. 90 pp.
- **Michael Kiparsky**. "In drought-stricken California, who owns water rights can still be a mystery." *Los Angeles Times*. July 15, 2021.
- Dave Owen, Alida Cantor, and **Michael Kiparsky**. "Opinion: State law recognizes rivers and groundwater are connected — now what?" *San Jose Mercury News*, May 9, 2018.
- Nell Green Nylen and **Michael Kiparsky**. "Are markets an easy solution for California's groundwater problems?" *Bakersfield Californian*, August 1, 2017.
- **Michael Kiparsky** and Holly Doremus. "California needs strong, fair and effective groundwater agencies." *Fresno Bee*, May 16, 2016.

**DAVE OWEN**

University of California, Hastings Law  
200 McAllister Street, San Francisco, CA 94102  
owendave@uchastings.edu – 415-703-8285

---

**ACADEMIC EMPLOYMENT**

Harry D. Sunderland Professor Law, University of California, Hastings Law.  
Professor of Law and Associate Dean for Research, University of Maine School of Law (2013-15)  
Associate Professor of Law, University of Maine School of Law (2007-13)

**PUBLICATIONS: BOOK, ARTICLES, AND REPORTS**

*Practicing Environmental Law* (Foundation Press, 2<sup>nd</sup> ed. 2021) (with Todd Aagaard & Justin Pidot).  
*Law, Land Use, and Groundwater Recharge*, 73 STAN. L. REV. 1163 (2021)  
*The Realities of Takings Litigation*, 47 BYU L. REV. 577 (2021)  
*Coequal Federalism and Federal-State Agencies*, 55 GA. L. REV. 287 (2020) (with Hannah Wiseman)  
*Consultants, the Environment, and the Law*, 61 ARIZ. L. REV. 823 (2019)  
*Private Facilitators of Public Regulation: A Study of the Environmental Consulting Industry*, REGULATION AND GOVERNANCE (2019).  
*California Groundwater Management, Science-Policy Interfaces, and the Legacies of Artificial Legal Distinctions*, ENVIRONMENTAL RESEARCH LETTERS (2019) (with Alida Cantor et al.)  
*Cooperative Subfederalism*, 9 UC IRVINE L. REV. 177 (2018)  
*Federal Laboratories of Democracy*, 52 UC DAVIS L. REV 1119 (2018) (with Hannah Wiseman)  
*Addressing Institutional Vulnerabilities in California's Drought Water Allocation* (2018) (with Nell Green Nylen et al.)  
*Navigating Groundwater-Surface Water Interactions under the Sustainable Groundwater Management Act* (2018) (with Alida Cantor et al.)  
*Water and Taxes*, 50 U.C. DAVIS L. REV. 1559 (2017).  
*Little Streams and Legal Transformations*, 2017 UTAH L. REV. 1.  
*Designing Effective Groundwater Sustainability Agencies: Criteria for Evaluation of Local Governance Options* (with Michael Kiparsky et al.).  
*Regional Federal Administration*, 63 UCLA L. REV. 58 (2016). Selected for reprinting in 48 LAND USE & ENVTL. L. REV. (2017) as one of the top five environmental law articles of 2015-16.  
*The Importance of Institutional Design for Distributed Local-Level Governance of Groundwater: The Case of California's Sustainable Groundwater Management Act*, MDPI WATER (2017) (with Michael Kiparsky et al.).  
*Predicting stream vulnerability to urbanization stress with Bayesian network models*, LANDSCAPE AND URBAN PLANNING (2017) (with Kristen K. Weil et al.).  
*Trading Dams*, 48 U.C. DAVIS L. REV. 1043 (2015) (co-authored with Colin Apse). Recipient of the Morrison Prize for Sustainability Scholarship.  
*Interdisciplinary Research and Environmental Law*, 41 ECOLOGY L.Q. 887 (2015) (coauthored with Caroline Noblet).

Overallocation, Conflict, and Water Transfers, 9 ENVTL. RES. LETTERS (2014)

Taking Groundwater, 91 WASH. U. L. REV. 253 (2014).

Mapping, Modeling, and the Fragmentation of Environmental Law, 2013 UTAH L. REV. 219. Reprinted in 46 LAND USE & ENVTL. L. REV. (2015) as one of the top six environmental law articles of 2013-14. Reprinted in the *Environmental Law and Policy Annual Review*, 45 Envtl. L. Rep. 10796 (2015) for receiving honorable mention as one of the top environmental law and policy articles of 2013.

The Mono Lake Case, The Public Trust Doctrine, and the Administrative State, 45 U.C. DAVIS L. REV. 1099 (2012)

Critical Habitat and the Challenge of Regulating Small Harms, 64 FLORIDA L. REV. 141 (2012), Reprinted in the *Environmental Law and Policy Annual Review*, 43 ENVTL. L. REP. 10662 (2013), as one of the top environmental law and policy articles of 2012.

Urbanization, Water Quality, and the Regulated Landscape, 82 U. COLORADO L. REV. 431 (2011).

Collaboration, Clean Water Act Residual Designation Authority, and Collective Permitting: A Case Study of Long Creek, 1 WATERSHED SCI. BULLETIN 25 (2010) (with Curtis Bohlen et al.).

Probabilities, Planning Failures, and Environmental Law, 84 TULANE L. REV. 265 (2009), Reprinted in 42 LAND USE & ENVTL. L. REV. (2011) as one of the top five environmental law articles of 2009-10.

Legal constraints, environmental variability, and the limits of innovative environmental governance, 12 ENVTL. SCI. & POL'Y 684 (2009).

Explaining the Klamath, 22 CONSERVATION BIOLOGY 1664 (2008) (book review).

Climate Change and Environmental Assessment Law, 33 COLUM. J. ENVTL. L. 57 (2008).

Law, Environmental Dynamism, Reliability: The Rise and Fall of CALFED, 37 ENVTL. L. 1145 (2008).

Technocracy and Democracy: Conflicts Between Models and Participation in Environmental Law and Planning, 56 HASTINGS L.J. 901 (2005) (co-authored with James Fine).

The Disappointing History of the National Marine Sanctuaries Act, 11 N.Y.U. ENVTL. L.J. 711 (2003).

Prescriptive Laws, Uncertain Science, and Political Stories: Forest Planning in the Sierra Nevada, 29 ECOLOGY L.Q. 747 (2003).

## **EDUCATION**

University of California, Berkeley School of Law (Boalt Hall), J.D. 2002

Honors: *Order of the Coif*

Amherst College, B.A., Geology 1996

Honors: *Magna cum laude*

## **PRIOR EMPLOYMENT**

2003-2007 Associate Attorney, Rossmann and Moore, San Francisco, California.

2002-2003 Clerk to Judge Samuel Conti, United States District Court, Northern District of California.

1996-2000 Geologist/Environmental Auditor, Woodard & Curran, Inc., Dedham, Massachusetts.



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Louise Bedsworth	Other agencies (including NSF) to which this proposal has been/will be submitted. None		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support		
Project/Proposal: Coyote Valley Credits Program			
Source of Support: Peninsula Open Space Trust			
Total Award Amount: 100,000.00		Total Award Period Covered: 01/01/2021 to 06/30/2022	
Location of Project: Berkeley, CA			
Person-Months Per Year Committed to the Project.		Cal: 4.80	Acad:
Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support		
Project/Proposal: A Protocol for Reduction of Methane in the Agriculture Sector			
Source of Support: Rockefeller Brothers Fund			
Total Award Amount: 100,000.00		Total Award Period Covered: 06/04/2021 to 05/04/2022	
Location of Project: Berkeley, CA			
Person-Months Per Year Committed to the Project.		Cal: 2.40	Acad:
Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support		
Project/Proposal: The Climate Leadership Training Program at CCCI			
Source of Support: Patrick J. McGovern Foundation			
Total Award Amount: 400,000.00		Total Award Period Covered: 02/19/2020 to 12/31/2022	
Location of Project: Berkeley, CA			
Person-Months Per Year Committed to the Project.		Cal: 0.60	Acad:
Sumr:			
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support		
Project/Proposal: California-China Climate Policy Institute			
Source of Support: William and Flora Hewlett Foundation			
Total Award Amount: 2,000,000.00		Total Award Period Covered: 08/01/2019 to 04/30/2022	
Location of Project: Berkeley, CA			
Person-Months Per Year Committed to the Project.		Cal: 2.00	Acad:
Sumr:			
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support		
Project/Proposal: San Francisco Climate Action Funding Consultant			
Source of Support: City of San Francisco			
Total Award Amount: 100,000.00		Total Award Period Covered: 01/01/2022 to 10/01/2022	
Location of Project: Berkeley, CA			
Person-Months Per Year Committed to the Project.		Cal: 2.00	Acad:
Sumr:			
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Ellen Bruno	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
COVID-19: Collaborative Research: Compounding Human and Natural Disasters: Implication on Agriculture Sectors			
Source of Support: National Science Foundation			
Total Award Amount: 100,000	Total Award Period Covered: 06/2020	to 05/2022	
Location of Project: UC Berkeley	Person-Months Per Year Committed to the Project.	Cal:	Acad: 0
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Decentralized management of integrated water resources: Understanding cross-scale decision feedbacks to support coordinated sustainability			
Source of Support: National Science Foundation			
Total Award Amount: 316,998	Total Award Period Covered: 09/2022	to 08/2026	
Location of Project: UC Berkeley	Person-Months Per Year Committed to the Project.	Cal:	Acad: 0
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Advancing Water Policy for Agricultural Sustainability			
Source of Support: Foundation for Food & Agriculture Research			
Total Award Amount: 391,954	Total Award Period Covered: 09/2021	to 08/2024	
Location of Project: UC Berkeley	Person-Months Per Year Committed to the Project.	Cal:	Acad: 0
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Securing a climate resilient water future for agriculture and ecosystems through innovation in measurement, management, and markets			
Source of Support: United States Department of Agriculture			
Total Award Amount: 924,646	Total Award Period Covered: 10/2021	to 09/2025	
Location of Project: UC Berkeley	Person-Months Per Year Committed to the Project.	Cal:	Acad: 0
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Assessing the potential of regenerative agriculture to support soil health and C sequestration			
Source of Support: California Department of Food and Agriculture			
Total Award Amount: 11,291	Total Award Period Covered: 01/2022	to 12/2024	
Location of Project: UC Berkeley	Person-Months Per Year Committed to the Project.	Cal:	Acad: 0
Sumr: 0			
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Helen Dahlke	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Securing a climate resilient water future for agriculture and ecosystems through innovation in measurement, management, and markets		
Source of Support: USDA NIFA			
Total Award Amount: 530,000.00	Total Award Period Covered: 09/01/2021 to 09/01/2025		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.24
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Sustaining Groundwater And Irrigated Agriculture In The Southwestern United States Under A Changing Climate		
Source of Support: USDA NIFA			
Total Award Amount: 419,563.00	Total Award Period Covered: 01/01/2022 to 12/31/2025		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.24
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Synergistic Managed Aquifer Recharge Strategies to Sustain Irrigated Agriculture		
Source of Support: USDA NRCS			
Total Award Amount: 800,000.00	Total Award Period Covered: 09/25/2020 to 09/24/2024		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.17
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Techniques to minimize nitrate loss from the root zone during managed aquifer recharge		
Source of Support: California Fertilizer Research and Education Program			
Total Award Amount: 224,623.70	Total Award Period Covered: 01/01/2021 to 12/31/2023		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.00
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Implementation of the Stream Aquifer Flow Exchange (SAFE) method in Integrated Water Flow Model (IWFMM)		
Source of Support: California Department of Water Resources			
Total Award Amount: 294,314.00	Total Award Period Covered: 06/01/2020 to 06/30/2022		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.24
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Helen Dahlke	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Quantifying the environmental effects of implementing managed agricultural aquifer recharge in agricultural production systems		
Source of Support: USDA NIFA			
Total Award Amount: 499,339.00	Total Award Period Covered: 01/01/2021 to 12/31/2023		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.24
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Developing science-based approaches to managed agricultural groundwater recharge in California's Central Valley		
Source of Support: The Gordon and Betty Moore Foundation			
Total Award Amount: 1,650,000.00	Total Award Period Covered: 10/26/2018 to 10/25/2022		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.24
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: CNH-L: The dynamics of rural poverty, land use, and water in California's changing Central Valley		
Source of Support: National Science Foundation			
Total Award Amount: 1,559,754.00	Total Award Period Covered: 09/01/2017 to 02/28/2022		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.36
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Regional Aquifer Management: Hydrology of Managed Aquifer Recharge in the Central Valley Aquifer and Mississippi Embayment		
Source of Support: USDA Economic Research Service			
Total Award Amount: 299,947.00	Total Award Period Covered: 10/01/2017 to 03/31/2022		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.38
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: ISES: Improving deliberative management of California's aquifer storage to promote social, economic and environmental co-benefits		
Source of Support: National Science Foundation			
Total Award Amount: 1,600,000.00	Total Award Period Covered: 09/01/2022 to 08/31/2025		
Location of Project: Davis, CA			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.14
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Andrew T. Fisher	Other agencies (including NSF) to which this proposal has been/will be submitted. None		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Recharge Net Metering (ReNeM) to secure water resources, enhance aquatic systems, sustain landscapes, and empower local institutions		
Source of Support: Gordon and Betty Moore Foundation (Bay Area Conservation), Award #9964			
Total Award Amount: 980,196.00		Total Award Period Covered: 11/01/2020 to 10/31/2023	
Location of Project: University of California, Santa Cruz			
Person-Months Per Year Committed to the Project.		Cal:	Acad:
			Sumr: 0.75
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Collaborative research: A state-of-the-art marine heat flow probe to Advance Interdisciplinary Research by the U.S. Academic Community		
Source of Support: U. S. National Science Foundation, Award OCE-1924384			
Total Award Amount: 176,526.00		Total Award Period Covered: 09/01/2019 to 08/31/2021	
Location of Project: University of California, Santa Cruz			
Person-Months Per Year Committed to the Project.		Cal:	Acad:
			Sumr: 0.33
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Exploring Ocean Worlds: Ocean System Science to Support the Search for Life		
Source of Support: NASA (WHOI Subcontact), Award A101474			
Total Award Amount: 471,196.00		Total Award Period Covered: 08/15/2019 to 08/14/2024	
Location of Project: University of California, Santa Cruz			
Person-Months Per Year Committed to the Project.		Cal:	Acad:
			Sumr: 0.63
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Stormwater Management Partnership		
Source of Support: USDA/NRCS (RCD Subcontract), Award # 1726			
Total Award Amount: 79,968.00		Total Award Period Covered: 11/01/2018 to 10/31/2023	
Location of Project: University of California, Santa Cruz			
Person-Months Per Year Committed to the Project.		Cal:	Acad:
			Sumr: 0.47
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Incentivizing and developing best practices to enhance groundwater supply and quality with managed recharge of non-traditional water sources		
Source of Support: U.S. Department of Agriculture/NIFA award 2021-67019-33595			
Total Award Amount: 349,744.00		Total Award Period Covered: 12/01/2020 to 11/30/2022	
Location of Project: University of California, Santa Cruz			
Person-Months Per Year Committed to the Project.		Cal:	Acad:
			Sumr: 0.50
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Andrew T. Fisher	Other agencies (including NSF) to which this proposal has been/will be submitted. None
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal: Center for Dark Energy Biosphere Investigations (C-DEBI), Phase 2	
Source of Support: U. S. National Science Foundation (USC Subcontract), Award OIA-0939564 Total Award Amount: 873,789.00 Total Award Period Covered: 10/01/2015 to 09/30/2022 Location of Project: University of California, Santa Cruz Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.50 Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal: Crustal Ocean Biosphere Research Exchange (COBRA)	
Source of Support: U. S. National Science Foundation Total Award Amount: 100,000.00 Total Award Period Covered: 10/01/2021 to 09/30/2026 Location of Project: University of California, Santa Cruz Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.43 Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal: A knowledge-to-implementation framework for enhanced aquifer recharge (this proposal)	
Source of Support: U. S. Environmental Protection Agency Total Award Amount: 263,496.00 Total Award Period Covered: 07/01/2022 to 06/30/2025 Location of Project: University of California, Santa Cruz Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.50 Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal:	
Source of Support: Total Award Amount: Total Award Period Covered: to Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal:	
Source of Support: Total Award Amount: Total Award Period Covered: to Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: *If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.	



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Thomas Harter	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Irrigation and Nitrogen Management and Monitoring to Improve Nut Production While Minimizing Groundwater Nitrate Leaching		
Source of Support: CDFA Specialty Crop Block Grant			
Total Award Amount: 450,000.00	Total Award Period Covered: 10/01/2019 to 03/31/2022		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Central Valley Groundwater Modeling Tool for CEAP		
Source of Support: US Department of Agriculture			
Total Award Amount: 275,000.00	Total Award Period Covered: 09/30/2018 to 09/30/2022		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Scott River Groundwater Study Scenario Implementation		
Source of Support: North Coast Regional Water Board			
Total Award Amount: 188,000.00	Total Award Period Covered: 07/01/2019 to 06/30/2022		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Antidegradation Policy Tool for Predicting Nitrate in Domestic and Production Wells by Machine Learning Techniques		
Source of Support: California State Water Resources Control Board			
Total Award Amount: 800,000.00	Total Award Period Covered: 07/01/2019 to 06/30/2024		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal: 0.60	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Central Valley Field CEAP		
Source of Support: US Department of Agriculture			
Total Award Amount: 560,450.00	Total Award Period Covered: 09/30/2019 to 09/30/2022		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Thomas Harter	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Synergistic Managed Aquifer Recharge Strategies to Sustain Irrigated Agriculture		
Source of Support: US Department of Agriculture			
Total Award Amount: 800,000.00	Total Award Period Covered: 09/01/2021 to 08/31/2025		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Techniques to Minimize Nitrate Loss from the Root Zone During Managed Aquifer Recharge		
Source of Support: CDFA FREP			
Total Award Amount: 225,000.00	Total Award Period Covered: 01/01/2021 to 12/31/2023		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Developing Science-Based Approaches to Managed Agricultural Groundwater Recharge in California's Central Valley		
Source of Support: Gordon and Betty Moore Foundation			
Total Award Amount: 1,650,000.00	Total Award Period Covered: 10/26/2018 to 10/25/2022		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Sustaining Groundwater and Irrigated Agriculture in the Southwestern United States Under a Changing Climate		
Source of Support: US Department of Agriculture			
Total Award Amount: 9,999,813.00	Total Award Period Covered: 10/01/2021 to 09/30/2026		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal:	Acad: 0.60	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Stakeholder-Supported Decision Making for Sustainable Conjunctive Management of Soil and Groundwater		
Source of Support: National Science Foundation / Belmont Forum			
Total Award Amount: 199,000.00	Total Award Period Covered: 01/01/2022 to 03/01/2024		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Thomas Harter	Other agencies (including NSF) to which this proposal has been/will be submitted.		
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Evaluating HFLC Nitrogen Management Strategies for Minimizing Reactive Nitrogen Mobilization from California Almond Orchards		
Source of Support: Almond Board of California			
Total Award Amount: 264,000.00	Total Award Period Covered: 09/01/2021 to 08/31/2024		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Colusa County Multi-Benefit, On-Farm Managed Aquifer Recharge Project		
Source of Support: The Nature Conservancy			
Total Award Amount: 183,423.00	Total Award Period Covered: 09/15/2019 to 09/30/2022		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal: 0.25	Acad:	Sumr:
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Developing Tools and Resources to Enable Economic, Institutional, and Technical Clarity in Support of Enhanced Aquifer Recharge Implementation (this proposal)		
Source of Support: EPA Environmental Protection Agency			
Total Award Amount: 2,000,000.00	Total Award Period Covered: 07/01/2022 to 06/30/2025		
Location of Project: California			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr: 0.50
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Source of Support:			
Total Award Amount:	Total Award Period Covered: to		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:		
Source of Support:			
Total Award Amount:	Total Award Period Covered: to		
Location of Project:			
Person-Months Per Year Committed to the Project.	Cal:	Acad:	Sumr:
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.			



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Michael Kiparsky	Other agencies (including NSF) to which this proposal has been/will be submitted. None
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
Project/Proposal: Improving Water Rights Administration and Oversight for Future Droughts	
Source of Support: State Water Resources Control Board	
Total Award Amount: 296,188.00	Total Award Period Covered: 06/25/2020 to 01/31/2023
Location of Project: Berkeley, CA	
Person-Months Per Year Committed to the Project.	Cal: 1.68 Acad: Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
Project/Proposal: Water Resource Innovation Project with Valley Water	
Source of Support: Santa Clara Valley Water District	
Total Award Amount: 79,994.00	Total Award Period Covered: 01/01/2021 to 12/31/2022
Location of Project: Berkeley, CA	
Person-Months Per Year Committed to the Project.	Cal: 2.00 Acad: Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
Project/Proposal: Recharge Net Metering to secure water resources, enhance aquatic systems, sustain landscapes, and empower local institutions	
Source of Support: Gordon and Betty Moore Foundation	
Total Award Amount: 157,968.00	Total Award Period Covered: 11/02/2020 to 11/01/2023
Location of Project: Berkeley, CA	
Person-Months Per Year Committed to the Project.	Cal: 1.80 Acad: Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
Project/Proposal: California-China Climate Policy Institute	
Source of Support: William and Flora Hewlett Foundation	
Total Award Amount: 2,000,000.00	Total Award Period Covered: 08/01/2019 to 04/30/2022
Location of Project: Berkeley, CA	
Person-Months Per Year Committed to the Project.	Cal: 2.00 Acad: Sumr:
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future	<input type="checkbox"/> *Transfer of Support
Project/Proposal: Securing a climate resilient water future for agriculture and ecosystems through innovation in measurement, management, and markets	
Source of Support: USDA National Institute for Food and Agriculture	
Total Award Amount: 230,163.00	Total Award Period Covered: 09/01/2021 to 08/31/2026
Location of Project: Berkeley, CA	
Person-Months Per Year Committed to the Project.	Cal: 1.80 Acad: Sumr:
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.	



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: Michael Kiparsky	Other agencies (including NSF) to which this proposal has been/will be submitted. None
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: National Priorities: Water Innovation, Science, and Engagement to Advance Water Reuse
<p>Source of Support: EPA Environmental Protection Agency</p> <p>Total Award Amount: 559,942.00      Total Award Period Covered: 05/01/2022 to 04/30/2026</p> <p>Location of Project: Berkeley, CA</p> <p>Person-Months Per Year Committed to the Project.      Cal: 1.80      Acad:      Sumr:</p> <p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal: Reinventing the Nation's Urban Water Reuse Systems (ReNUWeRs)</p>	
<p>Source of Support: EPA Environmental Protection Agency</p> <p>Total Award Amount: 3,245,670.00      Total Award Period Covered: 08/01/2022 to 07/31/2026</p> <p>Location of Project: Berkeley, CA</p> <p>Person-Months Per Year Committed to the Project.      Cal: 4.50      Acad:      Sumr:</p> <p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal: Developing tools and resources to enable economic, institutional, and technical clarity in support of Enhanced Aquifer Recharge implementation</p>	
<p>Source of Support: EPA Environmental Protection Agency</p> <p>Total Award Amount: 2,000,000.00      Total Award Period Covered: 07/01/2022 to 06/30/2025</p> <p>Location of Project: Berkeley, CA</p> <p>Person-Months Per Year Committed to the Project.      Cal: 3.00      Acad:      Sumr:</p> <p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal: California-China Climate Policy Institute</p>	
<p>Source of Support:</p> <p>Total Award Amount:      Total Award Period Covered: to</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project.      Cal:      Acad:      Sumr:</p> <p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal:</p>	
<p>Source of Support:</p> <p>Total Award Amount:      Total Award Period Covered: to</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project.      Cal:      Acad:      Sumr:</p>	
<p>*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.</p>	



## Current and Pending Support

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 0.5 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

*The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.*

Investigator: <b>Dave Owen</b>	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal: Developing tools and resources to enable economic, institutional, and technical clarity in support of enhanced aquifer recharge implementation
Source of Support: US Environmental Protection Agency	
Total Award Amount: 2,000,000.00	Total Award Period Covered: 07/01/2022 to 06/30/2025
Location of Project: Berkeley and San Francisco, CA	
Person-Months Per Year Committed to the Project.	Cal: 1.00 Acad: Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:
Source of Support:	
Total Award Amount:	Total Award Period Covered: to
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:
Source of Support:	
Total Award Amount:	Total Award Period Covered: to
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:
Source of Support:	
Total Award Amount:	Total Award Period Covered: to
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal:
*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.	

BRUCE BABBITT  
5169 Watson St. NW  
Washington, DC 20016

December 21, 2021

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I am pleased to support the research proposal entitled, "A knowledge-to-implementation framework for Enhanced Aquifer Recharge" (RFA EPA-G2022-STAR-C1). I recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. I would be delighted to see the University of California research team achieve its goals, and would be willing to engage with them by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. I look forward to participating with you in this project.

Sincerely,



Bruce Babbitt

FELICIA MARCUS

WILLIAM C. LANDRETH VISITING FELLOW, STANFORD UNIVERSITY

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I strongly support your research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). As you know, this is an issue that I have followed closely through my former role as Chair of the State Water Resources Control Board developing and implementing the Sustainable Groundwater Management Act (SGMA) and now as the William C. Landreth Visiting Fellow at Stanford University. I have been greatly impressed by the work of your team on a variety of critical issues essential to moving forward and accelerating the pace of MAR to meet the enormous challenges facing California and other parts of the world. I’m eager to see the University of California research team build on its previous successes and depth of experience in supporting EAR implementation. Extending your track record of many excellent and practical reports and publications would be of great value nationally. I would also very much like to see this team reprise and extend the Incentivizing Groundwater Recharge Symposium. The 2019 event was a very thoughtful and important contribution. I would be happy to participate in another version of this gathering and a ‘virtual roadshow’ to extend the insights to a broader audience. I would be pleased to engage with your team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. I look forward to participating with you in this project.

With much respect and gratitude for your work,



Felicia Marcus

William C. Landreth Visiting Fellow

Stanford University, Water in the West Program

[feliciaamarcus@gmail.com](mailto:feliciaamarcus@gmail.com)



GAVIN NEWSOM  
GOVERNOR



JARED BLUMENFELD  
SECRETARY FOR  
ENVIRONMENTAL PROTECTION

---

## State Water Resources Control Board

January 11, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

The State Water Resources Control Board, Division of Water Rights is pleased to support the research proposal entitled, "A knowledge-to-implementation framework for Enhanced Aquifer Recharge" (RFA EPA-G2022-STAR-C1). We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Respectfully,

Erik Ekdahl  
Deputy Director, Division of Water Rights  
State Water Resources Control Board  
Erik.Ekdahl@Waterboards.ca.gov

---

E. JOAQUIN ESQUIVEL, CHAIR | EILEEN SOBECK, EXECUTIVE DIRECTOR



## DEPARTMENT OF WATER RESOURCES

1416 NINTH STREET, P.O. BOX 942836  
SACRAMENTO, CA 94236-0001  
(916) 653-5791

January 12, 2022

Dr. Michael Kiparsky, Ph.D.  
Director, Wheeler Water Institute  
University of California, Berkeley  
Center for Law, Energy & the Environment  
Law Building  
Berkeley, CA 94720-7200

RE: Letter of Support for Enhanced Aquifer Recharge Research Proposal

Dear Dr. Kiparsky:

The Department of Water Resources (DWR) is pleased to provide this letter of support regarding the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” for the United States Environmental Protection Agency Science to Achieve Results Program. Within the last decade, California has experienced extreme changes in climate, with record drought years followed by atmospheric river storm events that produce intense flashes of precipitation and snowpack. Based on recent legislation to sustainably manage California’s groundwater, DWR provides planning resources to a network of interested parties and water managers developing local groundwater sustainability plans and programs, such as relevant datasets, groundwater modelling, and watershed analyses. A key area of emphasis for DWR is to provide technical, facilitation, and financial assistance to local water agencies to plan groundwater recharge and flood managed aquifer recharge efforts. Projects that promote this conjunctive water management approach can capture flood flows for groundwater recharge, replenish aquifers, and support diverse water users across our state, including communities, agriculture, and businesses. For these projects to be successful statewide, there is a great need to develop cost-benefit tools and frameworks to further analyze economic, technical, and institutional aspects of Enhanced Aquifer Recharge (EAR). By advancing research in this area, the life cycle costs of EAR can be more widely known across California’s varying watershed and groundwater conditions to advance viable, safe, and cost-effective EAR strategies at the local and regional scale with State government support and investment. DWR is pleased to support the collaborative proposal your research team developed, and looks forward to participating in your efforts.

Sincerely,

A handwritten signature in black ink that reads "Kamyar Guivetchi".

Kamyar Guivetchi, Manager  
Division of Planning

STATE CAPITOL, ROOM 5064  
SACRAMENTO, CA 95814  
TEL (916) 651-4003  
FAX (916) 651-4903

# California State Senate

**BILL DODD**

SENATOR, THIRD DISTRICT



CHAIR: SENATE GOVERNMENTAL ORGANIZATION COMMITTEE

COMMITTEES  
AGRICULTURE  
BUSINESS, PROFESSIONS AND  
ECONOMIC DEVELOPMENT  
VETERANS AFFAIRS  
TRANSPORTATION AND HOUSING  
SELECT COMMITTEE  
CALIFORNIA'S WINE INDUSTRY  
CO-CHAIR

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I write in strong support of your research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). I would like to see the University of California research team build on its previous successes and depth of experience in supporting EAR implementation. Extending your track record of impactful reports and publications on this topic would be of great value to California and to the national conversation on enhanced aquifer recharge. I would very much like to see the team conduct its planned symposium on EAR implementation. Your 2018 event on water decision making, at which I spoke, was thoughtfully conceived, based in rigorous research and facilitated engagement, and played a significant part in enabling the effective implementation of legislation I authored. As such, I would be very supportive of further efforts of this sort, given the importance of groundwater recharge to the state of California and the nation. To the extent the topics align with my legislative interests, I would be eager to participate in another symposium that you host on this topic, and support your team’s work through my office.

Respectfully,

A handwritten signature in black ink that reads "Bill Dodd".

BILL DODD  
Senator, 3<sup>rd</sup> Senate District



DOUGLAS A. DUCEY  
Governor

THOMAS BUSCHATZKE  
Director

ARIZONA DEPARTMENT of WATER RESOURCES  
1110 West Washington Street, Suite 310  
Phoenix, Arizona 85007  
602.771.8500  
azwater.gov

January 3, 2022

Dr. Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

Via email: [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

RE: Research Proposal "A knowledge-to-implementation framework for Enhanced Aquifer Recharge"  
(RFA EPA-G2022-STAR-C1)

Dear Dr. Kiparsky,

The Arizona Department of Water Resources (Department) recognizes that understanding the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, as well as the development methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts, will be important to long-term water management efforts. The Department supports the University of California's proposal to develop a deeper understanding, framework, methods, and tools to help advance recharge and water management resiliency, including efforts to obtain funding to achieve these goals. I was pleased to share insights into the Arizona Water Banking Authority for the case studies your team recently published. The Department will be happy to provide available information and respond to inquiries as appropriate, and as staff are able.

Sincerely,

A handwritten signature in black ink, appearing to read "Thomas Buschitzke".

Thomas Buschitzke  
Director

## DIRECTORS

DENIS R. BIODEAU, P.E.  
 JORDAN BRANDMAN  
 CATHY GREEN  
 NELIDA MENDOZA  
 DINA L. NGUYEN, ESQ.  
 KELLY E. ROWE, C.E.G., C.H.  
 STEPHEN R. SHELDON  
 TRI TA  
 BRUCE WHITAKER  
 ROGER C. YOH, P.E.



## OFFICERS

President  
 STEPHEN R. SHELDON  
 First Vice President  
 CATHY GREEN  
 Second Vice President  
 TRI TA  
 General Manager  
 MICHAEL R. MARKUS, P.E., D.WRE

**ORANGE COUNTY WATER DISTRICT**  
 ORANGE COUNTY'S GROUNDWATER AUTHORITY

January 5, 2022

Michael Kiparsky  
 Director, Wheeler Water Institute  
 Center for Law, Energy & the Environment  
 UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

**Subject: Letter of Support for Proposal to USEPA (RFA EPA-G2022-STAR-C1)**

Dear Dr. Kiparsky:

Orange County Water District is pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project. OCWD is a groundwater wholesaler serving 19 major retail water agencies and City water departments in North and Central Orange County in Southern California. As a critical part of our mission to provide a reliable, high quality water supply in a cost-effective and environmentally responsible manner, we conduct aquifer recharge to replenish groundwater, as well as maintain a seawater intrusion barrier. This local groundwater resource typically provides more than 75% of the annual water supply to more than 2.5 million residents. An important groundwater recharge source is our Groundwater Replenishment System (GWRS) in Fountain Valley, CA. At its current capacity of 100 million gallons per day (MGD), the GWRS AWPF is the world's largest water purification system for potable reuse.

Please feel free to contact me with any questions at (714) 378-3270 or [mplumlee@ocwd.com](mailto:mplumlee@ocwd.com).

Sincerely,

*Megan H Plumlee*

Megan H. Plumlee, Ph.D., P.E.  
Director of Research  
Orange County Water District  
18700 Ward Street, Fountain Valley, CA 92706



# IDAHO WATER RESOURCE BOARD

December 21, 2021

**Brad Little**  
*Governor*

**Jeff Raybould**  
*Chairman*  
St. Anthony  
At Large

**Roger W. Chase**  
*Vice-Chairman*  
Pocatello  
District 4

**Jo Ann Cole-Hansen**  
*Secretary*  
Lewiston  
At Large

**Dale Van Stone**  
Hope  
District 1

**Albert Barker**  
Boise  
District 2

**Dean Stevenson**  
Paul  
District 3

**Peter Van Der Meulen**  
Hailey  
At Large

**Brian Olmstead**  
Twin Falls  
At Large

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

On behalf of The Idaho Water Resource Board (IWRB), I want to express support of the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). The IWRB recognizes the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. The IWRB is supportive of collaboration with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Respectfully,

Wesley Hipke, P.G.  
Water Projects Section Supervisor  
Idaho Department of Water Resources



# Albuquerque Bernalillo County Water Utility Authority

PO Box 568  
Albuquerque, NM 87103  
www.abcwua.org

**Chair**

Steven Michael Quezada  
County of Bernalillo  
Commissioner, District 2

**Vice Chair**

Klarissa J. Peña  
City of Albuquerque  
Councilor, District 3

Walt Benson  
County of Bernalillo  
Commissioner, District 4

Pat Davis  
City of Albuquerque  
Councilor, District 6

Trudy E. Jones  
City of Albuquerque  
Councilor, District 8

Timothy M. Keller  
City of Albuquerque  
Mayor

Charlene Pyskoty  
County of Bernalillo  
Commissioner, District 5

*Ex-Officio Member*  
Pablo R. Rael  
Village of Los Ranchos  
Board Trustee

*Executive Director*  
Mark S. Sanchez

*Website*  
www.abcwua.org

January 5, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

The Albuquerque Bernalillo County Water Utility Authority (Water Authority) is pleased to support the research proposal entitled, "A knowledge-to-implementation framework for Enhanced Aquifer Recharge" (RFA EPA-G2022-STAR-C1). The Water Authority recognizes the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. The Water Authority is pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Respectfully,

Mark Kelly, P.E.  
Water Resources Division Manager  
Albuquerque Bernalillo County Water Utility Authority



December 29, 2021

Dr. Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email: [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Re: Letter of Support

Dear Dr. Kiparsky:

SAWS is pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert R. Puente".

Robert R. Puente  
President/CEO

*Omochumne Hartnell  
Water District*

O  
H  
W  
D

*Kurt A Kautz  
CHAIRMAN*

*Mark Stetars  
VICE CHAIRMAN*

*Mark Wilson  
TREASURE*

*Ken Mitchell  
DIRECTOR*

*Paul Hensleigh  
DIRECTOR*

*Michael Wackman  
GENERAL MANAGER*

*Shasta Burns  
BOARD SECRETARY*

January 6, 2021

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I am pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). I recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. I support the University of California research team and would be willing to engage with them by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. I look forward to participating with you in this project.

Thank you,

Mike Wackman

  
General Manager

*Phone: 916-682-5958*

*Street Address: 7513 Sloughhouse Road, Elk Grove, CA*

*Mailing Address: P.O. Box 211, Wilton, CA 95693-0211*

*Email:[info@ohwd.org](mailto:info@ohwd.org)*



January 5, 2022

Dr. Michael Kiparsky  
 Director, Wheeler Water Institute  
 Center for Law, Energy & the Environment  
 UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

Valley Water is pleased to support the research proposal titled, “A knowledge-to-implementation Framework for Enhanced Aquifer Recharge,” being submitted by you and colleagues to the U.S. Environmental Protection Agency (RFA EPA-G2022-STAR-C1). As a groundwater management agency, Valley Water recognizes the need to understand the interplay among economic, institutional, technical, and other aspects of enhanced aquifer recharge (EAR), and to develop methods and tools that enable water managers and stakeholders to implement recharge more effectively over a range of contexts. New tools for implementing EAR projects are critical for maintaining water security and sustainably managing groundwater basins. Valley Water currently operates EAR facilities to maintain water supply reliability and groundwater sustainability, actively participates in an out-of-county groundwater bank, and is working to develop new groundwater banking opportunities in California. Therefore, we can directly benefit from this project as it will provide implementation information and tools to better manage these systems. We are pleased to collaborate with the University of California research team by helping to refine research questions, providing information through documents and interviews, and reviewing drafts of written products, as appropriate based on topics and timing. We look forward to participating with you in this project.

Sincerely,

Gregory Williams  
 Deputy Operating Officer  
 Raw Water Division





*PAJARO VALLEY WATER MANAGEMENT AGENCY*

---

36 BRENNAN STREET • WATSONVILLE, CA 95076

TEL: (831) 722-9292 FAX: (831) 722-3139

info@pvwater.org • [pvwater.org](http://pvwater.org)

January 10, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

Pajaro Valley Water Management Agency (PV Water) is pleased to support the research proposal titled, “A knowledge-to-implementation Framework for Enhanced Aquifer Recharge,” being submitted by you and other colleagues to the U.S. Environmental Protection Agency (RFA EPA-G2022-STAR-C1). PV Water recognizes the need to understand the interplay between economics, institutional, technical, and other aspects of enhanced aquifer recharge, and to develop methods and tools that enable water managers like myself and interested parties to more effectively implement recharge in a range of contexts. PV Water has benefited greatly from years of productive collaboration with Dr. Fisher and his students, including through the now formalized Recharge Net Metering Program. Dr. Fisher, in collaboration with the Resource Conservation District of Santa Cruz County and individual property owners, has developed three projects, and PV Water looks forward to continuing its relationship with him and other research institutions in the interest of benefiting all Pajaro Valley water users. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate based on topics and timing. We look forward to participating with you in this project.

Kind regards,

Brian Lockwood, PG, CHG  
General Manager



820 Bay Avenue, Suite 136  
Capitola, California 95010  
tel 831.464.2950  
[www.rcdsantacruz.org](http://www.rcdsantacruz.org)

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

7 January 2022

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

The Resource Conservation District of Santa Cruz County (RCD) is pleased to support the research proposal titled, “A knowledge-to-implementation Framework for Enhanced Aquifer Recharge,” being submitted by you and colleagues to the U.S. Environmental Protection Agency (RFA EPA-G2022-STAR-C1). My colleagues and I recognize the need to understand the interplay between economics, institutional, technical, and other aspects of enhanced aquifer recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. The work proposed is directly relevant to and will help inform the groundwater recharge work that RCD is actively engaged in, including collaborations with private landowners, agriculture, NRCS, the Pajaro Valley Water Management Agency, and other stakeholders that are working to achieve a healthy and sustainable groundwater supply in our region. If approved for funding, RCD will be pleased to collaborate with and support the work of the University of California research team. We will draw on our experience and lessons learned to help refine research questions, inform the development of documents and interviews, review drafts of written products, and facilitate communication with landowners, agriculture industry representatives or other stakeholders as appropriate.

Best wishes with the proposal,

Lisa Lurie  
Executive Director

Scott Valley Irrigation District  
P.O. Box 126  
Fort Jones, CA 96032

January 4, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

Scott Valley Irrigation District is pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Respectfully,

Jim Morris  
S.V.I.D.



830 S. Street  
Sacramento, California 95811

tel [916] 449-2850  
fax [916] 442-2377  
nature.org

4 January 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

The Nature Conservancy is pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Best Regards,

A handwritten signature in black ink, appearing to read "Sandi Matsumoto".

Sandi Matsumoto  
Director, California Water Program  
The Nature Conservancy

# KERNWATERBANKAUTHORITY

January 5, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I am pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). I recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. I would be willing to engage with the University of California by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. I look forward to participating with you in this project.

Respectfully,  
Kern Water Bank Authority



Jonathan Parker,  
General Manager



Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

The Water Foundation is pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). We have supported sustainable groundwater management for the past decade. We recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. We are pleased to collaborate with the University of California research team by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. We look forward to participating with you in this project.

Respectfully,

A handwritten signature in blue ink that reads "Mike Myatt". The signature is fluid and cursive, with "Mike" on the top line and "Myatt" on the bottom line.

Mike Myatt  
Program Officer  
Water Foundation



January 6, 2022

Michael Kiparsky  
Director, Wheeler Water Institute  
Center for Law, Energy & the Environment  
UC Berkeley School of Law

via email, [kiparsky@berkeley.edu](mailto:kiparsky@berkeley.edu)

Dear Dr. Kiparsky:

I am pleased to support the research proposal entitled, “A knowledge-to-implementation framework for Enhanced Aquifer Recharge” (RFA EPA-G2022-STAR-C1). I recognize the need to understand the interplay between economics, institutional, technical, and other aspects of Enhanced Aquifer Recharge, and to develop methods and tools that enable water managers and stakeholders to more effectively implement recharge in a range of contexts. I would be delighted to see the University of California research team achieve its goals, and would be willing to engage with them by helping to refine research questions, provide information through documents and interviews, and review drafts of written products, as appropriate. I look forward to participating with you in this project.

Respectfully,

  
Don J. Cameron  
Vice President-GM  
Terranova Ranch Inc.

**BUDGET INFORMATION - Non-Construction Programs**OMB Number: 4040-0006  
Expiration Date: 02/28/2022**SECTION A - BUDGET SUMMARY**

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. LIFE-CYCLE ANALYSIS TO SUPPORT COST-EFFECTIVE ENHANCED AQUIFER RECHARGE	66.509	\$ [ ]	\$ [ ]	\$ 2,000,000.00	\$ [ ]	\$ 2,000,000.00
2.						
3.						
4.						
<b>5. Totals</b>		\$ [ ]	\$ [ ]	\$ 2,000,000.00	\$ [ ]	\$ 2,000,000.00

Standard Form 424A (Rev. 7- 97)

Prescribed by OMB (Circular A -102) Page 1

## SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total (5)
	(1) LIFE-CYCLE ANALYSIS TO SUPPORT COST- EFFECTIVE ENHANCED AQUIFER RECHARGE	(2) N/A	(3) N/A	(4) N/A	
a. Personnel	\$ 183,785.00	\$ 303,927.00	\$ 195,631.35	\$ 0.00	\$ 683,343.35
b. Fringe Benefits	52,176.09	63,004.31	51,653.65	0.00	166,834.05
c. Travel	6,602.00	8,602.00	6,602.00	0.00	21,806.00
d. Equipment	0.00	0.00	0.00	0.00	0.00
e. Supplies	2,500.00	0.00	0.00	0.00	2,500.00
f. Contractual	0.00	0.00	0.00	0.00	0.00
g. Construction	0.00	0.00	0.00	0.00	0.00
h. Other	130,237.89	180,336.89	217,762.89	0.00	528,337.67
i. Total Direct Charges (sum of 6a-6h)	375,300.98	555,870.20	471,649.89	0.00	\$ 1,402,821.07
j. Indirect Charges	161,572.39	247,036.23	188,570.31	0.00	\$ 597,178.93
k. TOTALS (sum of 6i and 6j)	\$ 536,873.37	\$ 802,906.43	\$ 660,220.20	\$ 0.00	\$ 2,000,000.00
7. Program Income	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00

Authorized for Local Reproduction

Standard Form 424A (Rev. 7-97)  
Prescribed by OMB (Circular A -102) Page 1A

## SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program		(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8.	LIFE-CYCLE ANALYSIS TO SUPPORT COST-EFFECTIVE ENHANCED AQUIFER RECHARGE	\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]
9.	[ ]	[ ]	[ ]	[ ]	[ ]
10.	[ ]	[ ]	[ ]	[ ]	[ ]
11.	[ ]	[ ]	[ ]	[ ]	[ ]
12. TOTAL (sum of lines 8-11)		\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]

## SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]
14. Non-Federal	\$ [ ]	[ ]	[ ]	[ ]	[ ]
15. TOTAL (sum of lines 13 and 14)	\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]	\$ [ ]

## SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS)			
	(b)First	(c) Second	(d) Third	(e) Fourth
16. LIFE-CYCLE ANALYSIS TO SUPPORT COST-EFFECTIVE ENHANCED AQUIFER RECHARGE	\$ 536,873.37	\$ 802,906.43	\$ 660,220.20	\$ 0.00
17.	[ ]	[ ]	[ ]	[ ]
18.	[ ]	[ ]	[ ]	[ ]
19.	[ ]	[ ]	[ ]	[ ]
20. TOTAL (sum of lines 16 - 19)	\$ 536,873.37	\$ 802,906.43	\$ 660,220.20	\$ 0.00

## SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:	1,402,823.27	22. Indirect Charges:	597,176.73
23. Remarks: [ ]			

Authorized for Local Reproduction

Standard Form 424A (Rev. 7- 97)  
Prescribed by OMB (Circular A -102) Page 2